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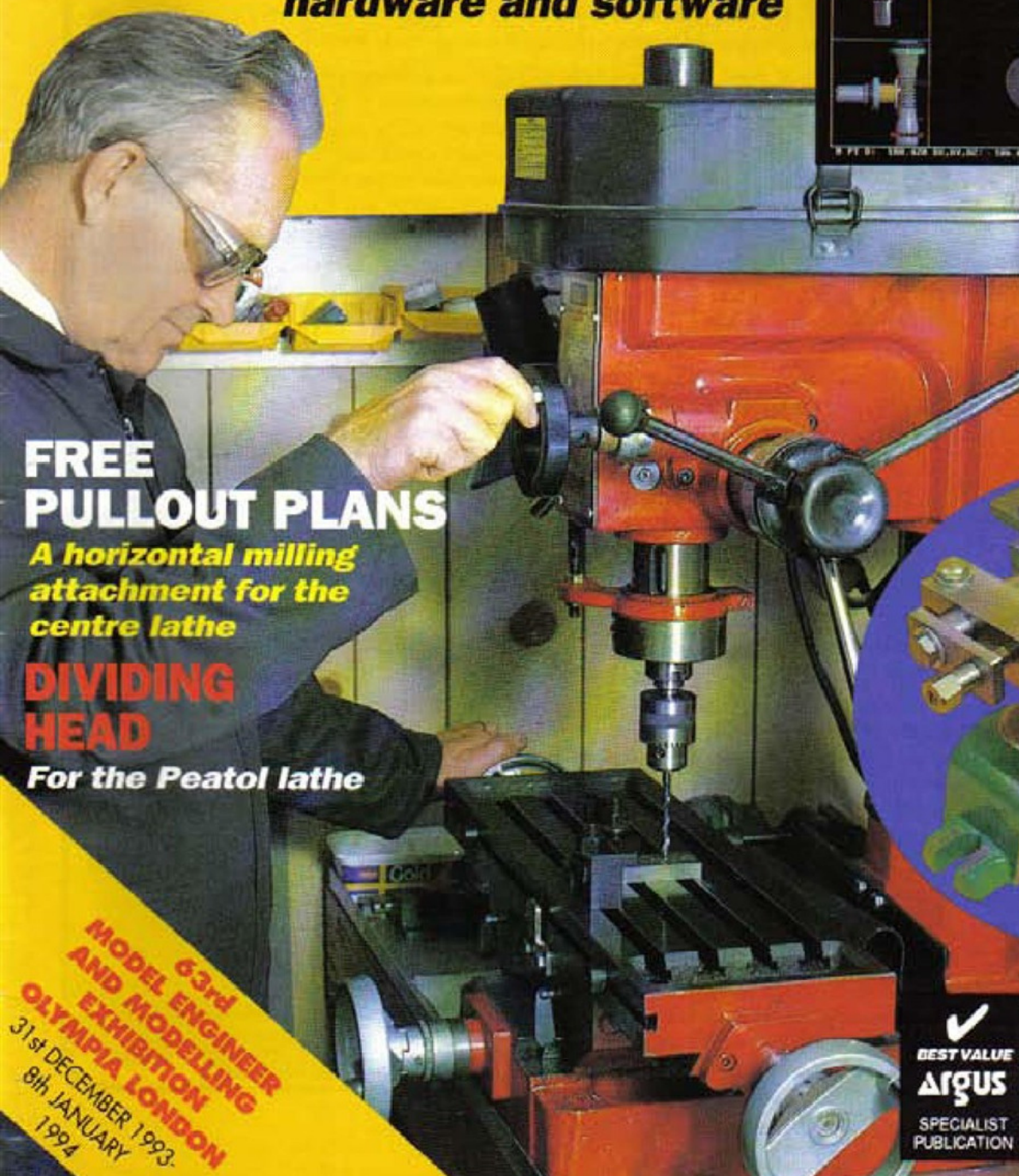
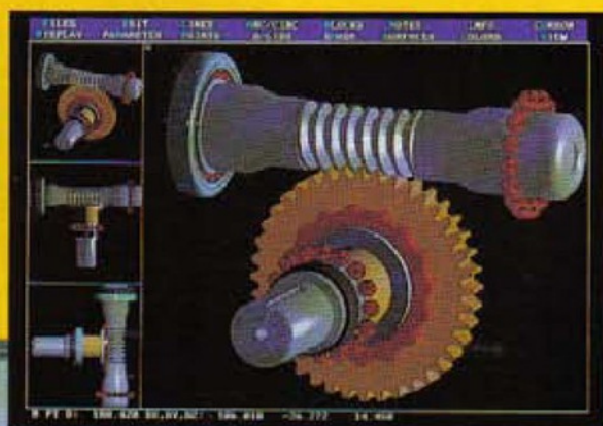
MODEL ENGINEERS'

WORKSHOP

THE PRACTICAL HOBBY MAGAZINE

COMPUTER - AIDED DRAWING

*Choosing and using CAD
hardware and software*



FREE PULLOUT PLANS

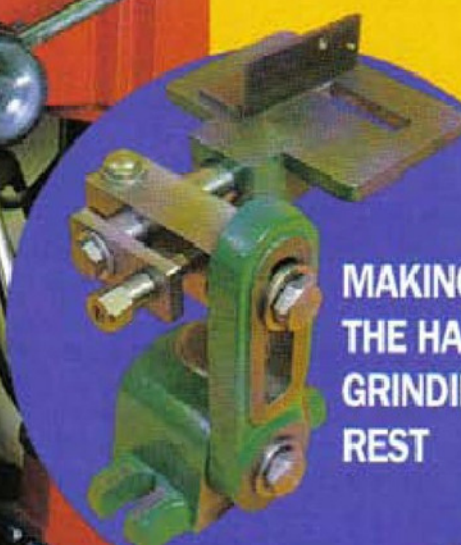
*A horizontal milling
attachment for the
centre lathe*

DIVIDING HEAD

For the Peatol lathe

MAGNETIC POST

*Novice's
project*



MAKING
THE HART
GRINDING
REST

63rd
MODEL ENGINEER
AND MODELLING
EXHIBITION
OLYMPIA LONDON
31st DECEMBER 1993
8th JANUARY
1994


BEST VALUE
Argus
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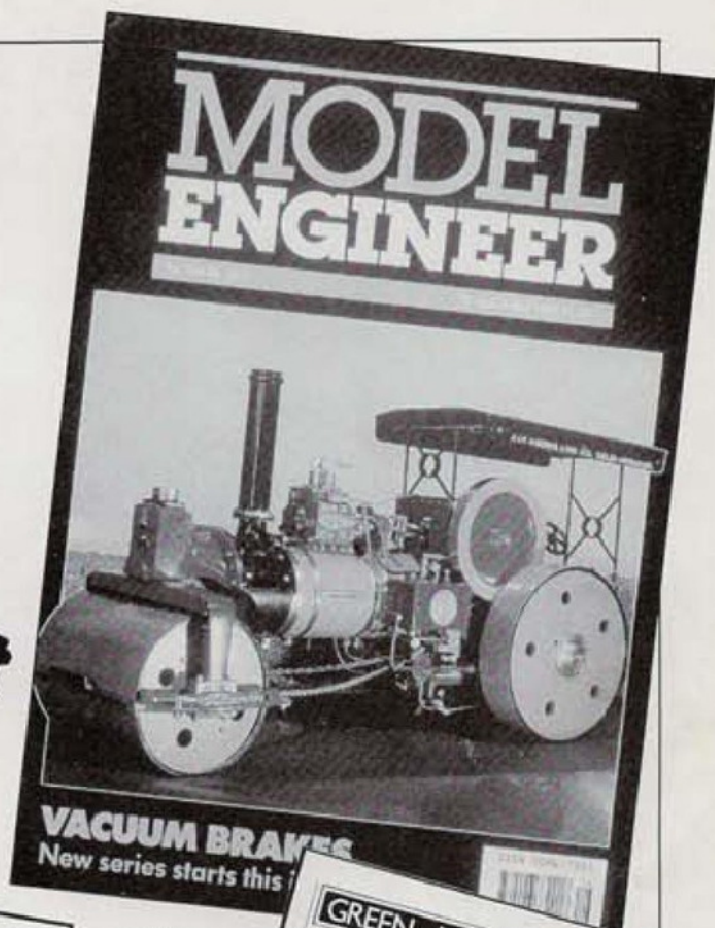


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**SOMETHING
TO LOOK
FORWARD
TO...**
...every fortnight



There's something to anticipate twice every month in fascinating Model Engineer magazine! Whether your interests lie in live steam locomotive models, traction engines, internal combustion motors or stationary engines, world famous M.E. will inspire, instruct, advise and encourage. Model Engineer is published on the first and third Fridays each month and costs just £1.40 from all good newsagents; alternatively, you may care to ensure your regular copies through an annual subscription - a mere £33.60 for UK readers (overseas rates and airmail details on request).

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Argus House,
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HP2 7ST
Tel: 0442 66551

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Editor: Harold Hall

Argus Specialist Publications, Argus House, Boundary Way, Hemel Hempstead, HP2 7ST, tel. 0442 66551

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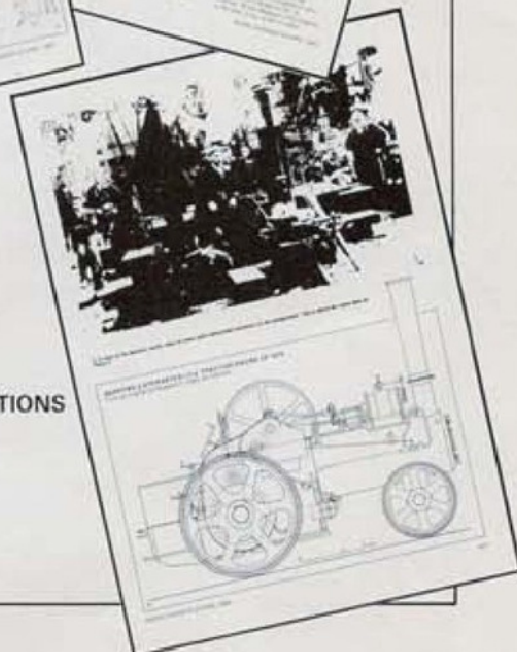
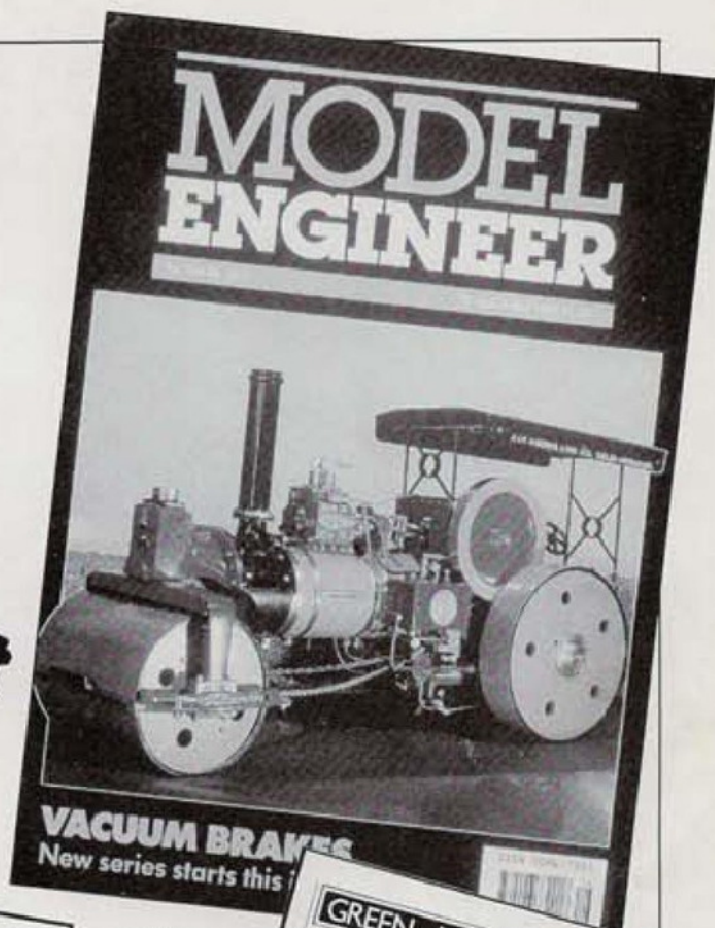
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ON THE EDITOR'S BENCH

Harold Hall

The official publication date for this issue is December 24, Christmas Eve. To those who normally receive their copies a day or two early, and find time to read this at this busy period, may I express my greetings at the time of this Christmas festival. However, for the majority I feel, Christmas will be over by the time this is read. If like me, you have thrown out that hint regarding some item lacking in your workshop, I do hope that the hint has been heeded and that you now have some new item to further expand your workshop capabilities. For me, having done this since a child, my workshop is extensively equipped and I find it increasingly difficult to make any suggestions along these lines. It may be that some new item received will render some existing item obsolete, so why not make use of our new feature *Link Up* to find it a good home.

Link Up

A number of readers have already written expressing their appreciation on the feature *Link Up*; the first contributions are to be found elsewhere in this issue. It is anticipated that this will generate a large number of requests etc, and for this to be acceptable at this end, it is essential that a few requirements are met by those writing in. May I therefore briefly bring three points to your notice.

If you are writing regarding other matters at the same time, please place your item for *Link Up* on a separate sheet of paper. Write your name and address at the top of the sheet as normal, and then write out your contribution exactly as it is to be published, this must include phone number or address. Keep it short.

The requirements for using the facility will be published from time to time for the benefit of new readers and to satisfactorily get it off the ground.

Model Engineers' Workshop Data Book

Question 26 of the recent reader survey asked for comments on readers preferences regarding free, publishers wording not mine, gifts. Competitions gained a very low vote as did cover mounted gifts. At the other end of the scale, with 47% voting in their favour, were wall charts. However this was almost equalled by money saving offers and free plans. Booklets and supplements also scored well.

The desire for wall charts obviously shows readers' interest in facts and figures relating to workshop activity. This was also evident in the comments on what readers would like to be covered in the booklets. One reader even suggested that mini versions of the well known *Machinery's*

Handbook and *Kempes Engineers Year Book* would be a good idea. Having myself purchased these at £55.00 and £99.00 respectively, it shows that this reader's sights are set high, and why not.

It has been decided that, starting in the next issue, Data Sheets will be issued on a wide range of subjects. These will pull out from the centre of the magazine, but will not be page numbered as part of it, in similar fashion to the pull out plans hitherto issued. Their removal will not therefore destroy the long term reference value of the issue. The pages will be arranged for splitting down to A5 size (210mm x 148mm) and fitting into a loose leaf ring binder. It is felt that this size best suits use in the workshop.

Most people have access to a photocopier these days, if only via a local print shop, and for those who want wall charts, they can select the most frequently referred to pages and photocopy these onto a larger sheet. However, readers have commented on their not having any spare wall for such data sheets.

The data book will have the more normal data, such as thread details, pitch, form and tapping sizes, drill sizes, Imperial to metric conversions and others. Sections will be included covering, amongst others, mathematical formulae and tables, electrical formulae and preferred component sizes and material specifications.

A ring binder, suitably titled, will be available for purchase. Some may prefer to take the more economical approach and make their own, the ambitious may even like to try their hand at book binding and bind them into a book. Do not leave them in the magazines, as they will cease to achieve their function of a readily available source of workshop facts and figures.

The project is an ambitious one; it will take quite a number of issues for it to reach a high standard of completion. In any case, if considered desirable, additional sheets could be added, even at a much later date.

CAD

If you read the article on CAD in the last issue and, as a result, considered that just possibly it may be worth your while setting up your own system, then the second item on CAD published in this issue is for you. If on the other hand you found the item just interesting, you may still find it worth reading this issue's offering on the subject. It is intended for those who are considering taking the idea further, and will give an insight into the problems, but, having read it, there will still be much homework to be done. It is unfortunately not a simple exercise to start from scratch.

The article lists a few available CAD packages, and indicates those that are very easy to learn; on the assumption that if more effort than the most basic is needed to master the system, many readers may be put off even attempting this process.

Many enthusiasts will be dogmatic that the most able computer is a necessity for

modern computer programs; this is certainly the way things are going. But, should you already own a personal computer built to an earlier standard, or can only afford to purchase a secondhand unit; I should point out that the programs were tested and found very able on a machine compatible to the IBM XT standard. If on the other hand you are purchasing new, then such machines are no longer available and you will have no choice but to move up the ladder. Buy the most able that you can. In any event, the cost of machines has been falling steadily; a present day 386 machine (three steps up from the XT) will probably be cheaper than an XT was only some three years ago.

Anyone attempting to get to grips with a computer program from scratch, be it a word processor, data base or spread sheet etc, will understand that this can frequently be a time consuming and mentally demanding operation. CAD systems are no exception; attempting to learn the ins and outs of more than one system, for the purposes of the review, multiplies the problem at an alarming rate. From the lessons learnt, this is an exercise that I would only take on again with considerable reluctance. It must be said the exercise was very rewarding, once concluded; I hope the problems experienced will not be too evident in the article as published.

If you have little or no experience in choosing and using computers, read the article in this issue on the subject by Michael Oppenheim. Michael is a professional in the field of computer tuition and is well able to provide this article.

Quick Tip error

Most readers will appreciate that it is impractical to check out every *Quick Tip* that is presented for publication. Similarly, in some articles, where access to a particular machine is essential to check out certain dimensions, the author's facts have to be taken as accurate if I do not have this machine available to check against.

Unfortunately, one *Quick Tip* that was easy to check escaped the net and was published with an error. The error was then compounded, it was, by mistake, published a second time, still in its original form, before I knew about the error.

The tip in question, first published in issue 19 on page 15 and repeated in issue 20 on page 51, is shown correctly at the end of this page. Do go back and correct these tips for the benefit of future readers of the magazine.

Corrected Quick Tip Milling Formulae

If you need to mill a square or hexagonal head on a piece of round material, the following formulae will give the minimum diameter of material required.
Square: $AF \times 1.415$ Hex: $AF \times 1.155$

The 63rd Model Engineer and Modelling Exhibition

As most of you will know this is to be held at Olympia from 31 December 1993 - 8 January 1994. I hope that many readers will visit the exhibition. I shall be attending myself on several days. Do please make yourself known if you see me in the exhibition, it is always nice to meet readers. The advertisement elsewhere in this issue gives full details of opening times etc.



LINK UP

Reader to reader service - help - queries -
small sales - wants - and it is all free!!
Plain = Wants, Tinted = For Sale

I am looking for short machine shop courses, a week, weekend or maybe a day. These are frequently advertised in *Woodworker* but not in *Model Engineers' Workshop*. Do any readers know of such courses. Would be prepared to travel. (Are any of our more experienced readers prepared to give instruction on a one to one basis? Ed.) Kent 0474 704617.

I am trying to teach myself engineering and would be most grateful if anyone in the Weston-Super-Mare area would consider giving some advice, perhaps allow a visit or two. McLaughlin 21 Ash Rd, Banwell, Weston-Super-Mare, Avon, BS24 6JB.

Having acquired a Pollard Corona horizontal milling machine, model 1AX, I am interested in obtaining a manual, spares list etc. Also are spares available from any source? 0302 852482.

Can any reader supply me with a copy of the instruction manual for the Emco Maximat V10 P Lathe Serial No. C7403195. Roberts, 19 Leighton Ave. Meols, Wirral, Merseyside, L87 0LY. 051 632 4906.

I require some square steel tubing 1/2in. x 18 gauge, about 8ft., could be in shorter lengths. Can any reader offer some, or suggest a possible source. 0276 24252.

I have a W. Von Pittler B2 lathe 3 1/2in. x 10in. I have been told it was made in 1920 but it looks in too good condition to be that old. I would like to know more about the company and whether they were ever made in this country. I would like, if any

reader has same, a copy of the handbook, screw cutting charts etc. also to purchase a fixed steady. 0204 306008.

I am restoring an elderly cutter grinder made by K.O. Lee of South Dakota, U.S.A. Has anyone any information of any kind relating to this machine or the manufacturer? 081 330 1486.

I have a Harrison 140 gap bed lathe, serial no 143413. Can anyone help with a copy of the instruction manual and/or spare parts list? Yates, 43 Church Road, Salisbury, Wilts SP4 0AT. 0980 610404.

I have an Arboga mill/drill model EM825. This has a No. 3 Morse taper, but no draw bar, how are tools intended to be secured? Any information re a manual, importers, tooling, etc. will be most welcome. Squire, 58 Apley Way, Witney, Oxon, OX8 5BO. 0993 705870.

Require about 5 ft., in one length, of 21 swg spring steel (piano) wire. Can anyone help? 0642 319999.

Have a Pallas HO horizontal mill with vertical head, apparently with all original tooling. I guess around 1938. Would enjoy talking to another owner. 0553 840639.

A Midgley and Sutcliffe Richmond horizontal milling machine that I have uses Brammer C Belting for the drive. Three speeds are provided via stepped pulleys but what puzzles me is that there is no means for slackening the belt, and so it has to be moved by brute force. I have no information regarding the machine so would be grateful to receive any that any reader can provide. Also can anyone supply some Brammer C belting, even used will be acceptable. Norton 5 Rydon Lane, Taunton, Somerset, TA2 7AO. 0823 277592.

I have in my possession an Adept hand shaper which I believe to be a Model No.1. This diagnosis I base only upon pictures of the No.2 that I have seen in books and am more than willing to be proven incorrect on this point. I would be delighted to identify it, so if anybody in the general area of West Berkshire (preferably Newbury) who has a No.1 hand shaper that I could inspect to assist me in the identification of my own shaper, and take measurements from to enable me to complete the refurbishment to as near original condition as possible. 0635 521842.

Has anyone a manual for the Senior "E" Vertical Milling Machine? 0455 634550.

Wanted 6 inch diameter 'Eclipse' magnetic chuck, Tel 0322 330556 (N.W. Kent).

For sale Pye 'Tasc' variable speed drive 1/2HP output. Spec available. £40 + carriage. Also vacuum pump old but serviceable. £10 + carriage. Tel 0322 330556 (N.W. Kent).

Imperial dial indicator, 0.3in. travel, with five accessories, including inside attachment, and in a lined case. Old, but all very sound. £15.00 (Herts) 0442 863026.

Vertical Swivel Slide to suit Boxford lathe. 4.8in. x 8in. table with four tee slots. As new. £50.00 (Rochdale) 0706 360849.

A micrometer adjusted Height Gauge complete with box of standards, all in fitted wood case. The gauge can be used either in the manually adjusted mode for quick use, or for more precise measurements, by using the integral micrometer screw. The scribe is of the conventional chisel edge type, typical of accurately adjustable height gauges. Price £27.50 inclusive of packing and carriage, returnable should the purchaser not be satisfied. (U.K. only). 0962-890475. Winchester, Hants.

That's it - the first selection of items for you to ponder over in Link Up.

Link Up - how it works and conditions for using the feature - a note from the Editor

Requests should be written exactly as intended to be published and marked *Link Up*, additionally, place name and address at top of page.

Comments to the editor on the subject of the *Link Up* request, or other subject, must be in a separate accompanying letter.

There is no limit to the length, however, keep please it brief. In the case of a request for help with an old machine of uncertain make, a photograph may be provided for publication. (Original will not be returned).

The letter must contain for publication, telephone number and/or address. Please make it clear, exactly what you want us to publish.

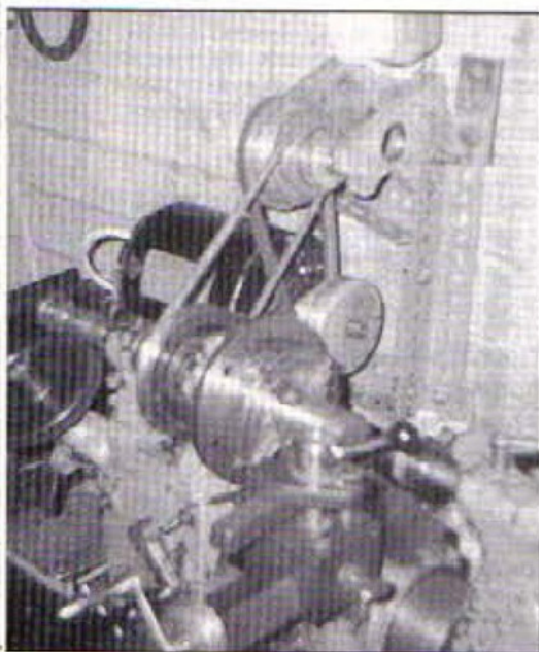
Only in the case of communications between countries where the cost of a phone call may be prohibitive, and an address has not been given, letters will be redirected as follows. Replies should be sent in a sealed and stamped envelope, marked with the name of the recipient, and an accompanying note, marked for the attention of the editor, referring to *Link Up* and quoting the issue in which the item was published.

In the case of items for sale, up to five items can be included providing descriptions are brief, total value must not exceed £50.00. Similarly, the probable value of wanted items, must not exceed this value.

Photographs of items offered for sale will not be published.

Letters should preferably be typed, but if hand written, name, address and/or telephone number must be clearly printed in block capitals. If any doubt exists, the request will not be published.

The facility is available to private readers only.



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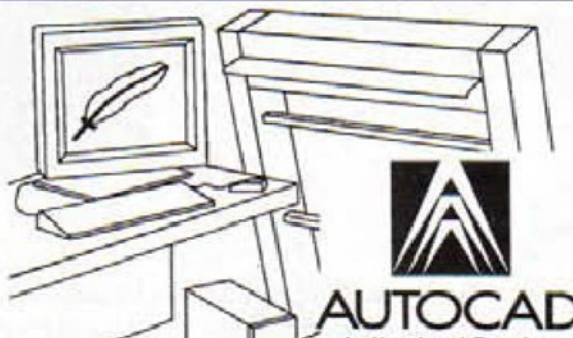
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The products are mainly electrical and electronic, but there are a large number of hardware items and tools. The catalogue can be ordered by phone with credit card or if you are quick, by post, please mention M.E.W. The service from this company is excellent. Electromail, P.O. Box 33, Corby, Northants NN17 9EL. Tel. 0536 204555. Fax. 0536 405555.

South Bend lathe accessories

Recent letters published in Scribe a Line relating to South Bend lathes, and the resulting correspondence, showed that there is considerable interest in these machines. Owners may be interested to learn of Metal Lathe Accessories of Redhill, who supply a range of parts/castings etc. for building accessories for these lathes. The list includes such items as tee slotted cross slides, vertical slides, rear mounted tool post and many others.

Some are also suitable for Boxford and Atlas lathes; items such as vertical slides will probably be usable on other similar size lathes. The parts originate in the U.S.A. and are marketed in the U.K. by Metal Lathe Accessories, Town Farm, Outwood Lane, Bletchingley, Surrey, RH1 4LR. Tel. 0883 743961.

South Bend spares

The U.K. agent for South Bend spares is Thoka Machinery Supplies Ltd, 39 Kings Road, Brentwood, Essex, CMI4 4DJ. Tel. 0277 232424.

Detach yourself with Loctite!

"Ever been about to finish a delicate or tricky gluing job and found yourself left with nothing but sticky fingers, spilt glue and all the wrong things attached?" Well now you don't have to worry any more. Loctite, manufacturer of Super Glue 3, has come to the rescue by launching Detach, the U.K.'s first all-purpose glue remover, designed to remedy gluing accidents fast.

Detach is suitable for use across the board, not just with Loctite products. It can be used with Super Glue 3 and most other household adhesives (except epoxy resins) to remove glue from skin, badly bonded items, stained surfaces, clothes and fabrics. Traces of sticky labels can be removed too.

In most cases just two or three drops of Detach are sufficient to solve the problem. Glue can be removed from sticky fingers within seconds by adding the solution, waiting for the glue to soften and then

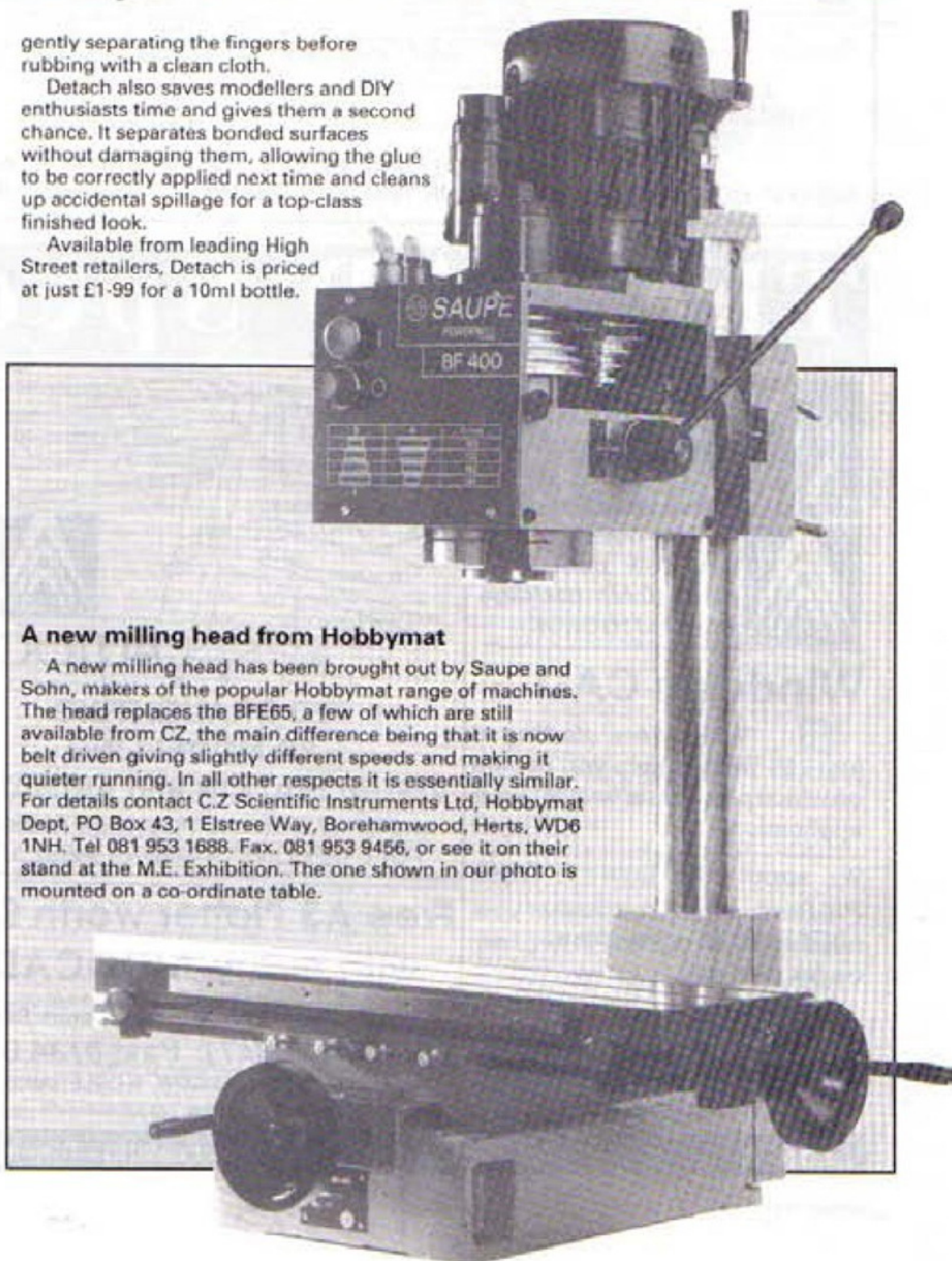
gently separating the fingers before rubbing with a clean cloth.

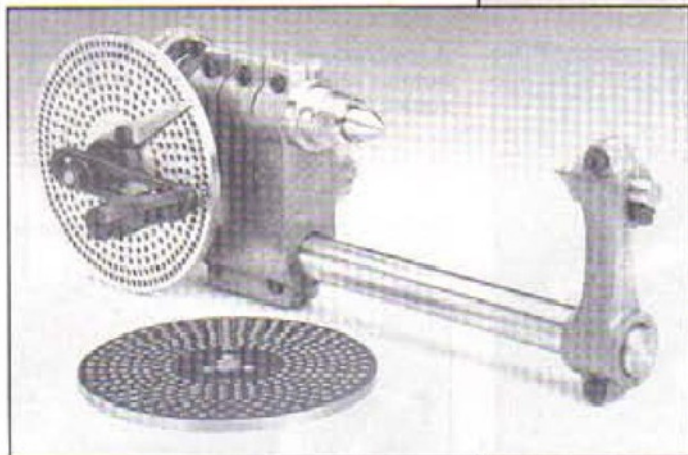
Detach also saves modellers and DIY enthusiasts time and gives them a second chance. It separates bonded surfaces without damaging them, allowing the glue to be correctly applied next time and cleans up accidental spillage for a top-class finished look.

Available from leading High Street retailers, Detach is priced at just £1.99 for a 10ml bottle.

A new milling head from Hobbymat

A new milling head has been brought out by Saupe and Sohn, makers of the popular Hobbymat range of machines. The head replaces the BFE65, a few of which are still available from CZ, the main difference being that it is now belt driven giving slightly different speeds and making it quieter running. In all other respects it is essentially similar. For details contact C.Z. Scientific Instruments Ltd, Hobbymat Dept, PO Box 43, 1 Elstree Way, Borehamwood, Herts, WD6 1NH. Tel 081 953 1688. Fax. 081 953 9456, or see it on their stand at the M.E. Exhibition. The one shown in our photo is mounted on a co-ordinate table.





New catalogues

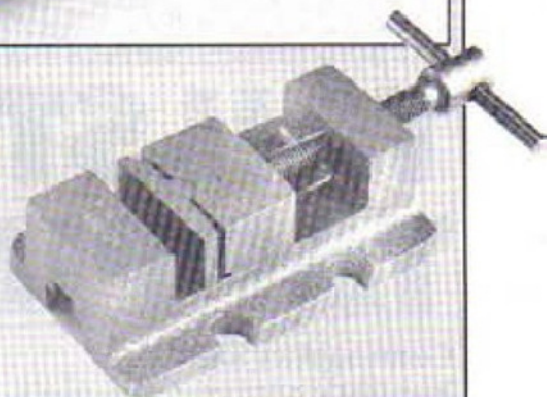
A new much larger catalogue is available from Frost Auto Restoration Techniques Ltd. Whilst aimed primarily at the car restorer and repairer, it has many items of interest to the home workshop owner, whatever their interest. For a free copy, send to the following address mentioning Model Engineers' Workshop:- Frost Auto Restoration Techniques Ltd, Crawford Street, Rochdale, OL16 5NU. Tel. 0706 58619. Fax 0706 860338.

The latest catalogue from Kirjeng M.E. Services is now available. The catalogue contains a wide range of hand tools, precision tools, materials, fixings and many other items. It can be obtained by sending an A5, or larger, s.a.e. to Kirjeng M.E. Services, 17 Gable Lea, Sutton Bonington, Leics, LE12 5NW. Tel. 0509 672025.

Changes at Myford

The well known dividing attachment and taper turning attachment made for a number of years by Myford have both seen major changes in the way they are manufactured. Myford's production engineers have applied the latest CNC manufacturing techniques, resulting in appreciable reduction in their prices.

Another well known item, the Myford No. 71 vice, has come to the end of the line after 50 years of manufacture. As a result, the last batch is being sold at a reduced price of £40.75 + VAT and postage.



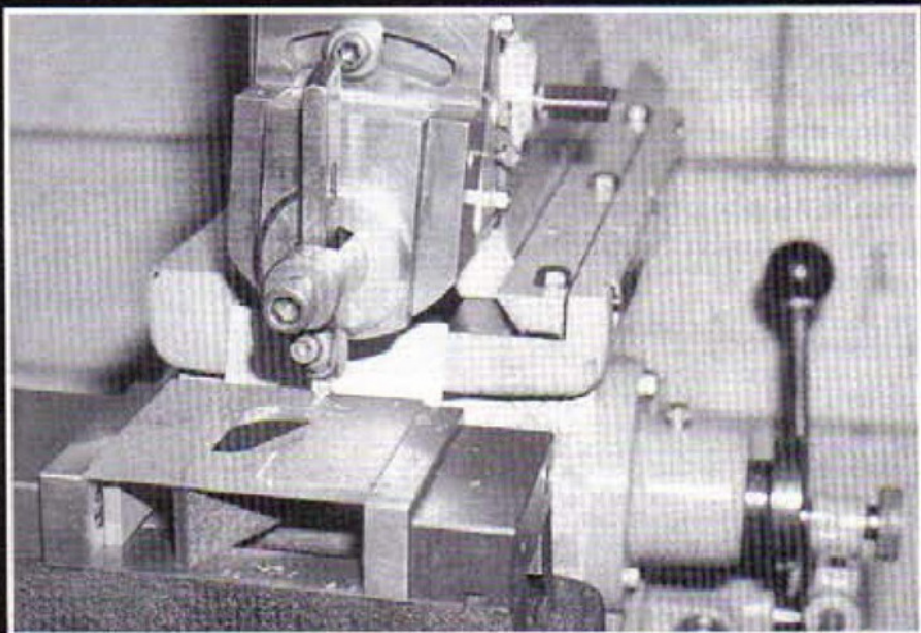
For details contact Myford Ltd, Chilwell Road Beeston, Nottingham, NG9 1ER. Tel. 0602 254222. Fax: 0602 431299.

IN OUR NEXT ISSUE!

Contents may be changed

Coming up in the MARCH/APRIL issue No. 22 will be:

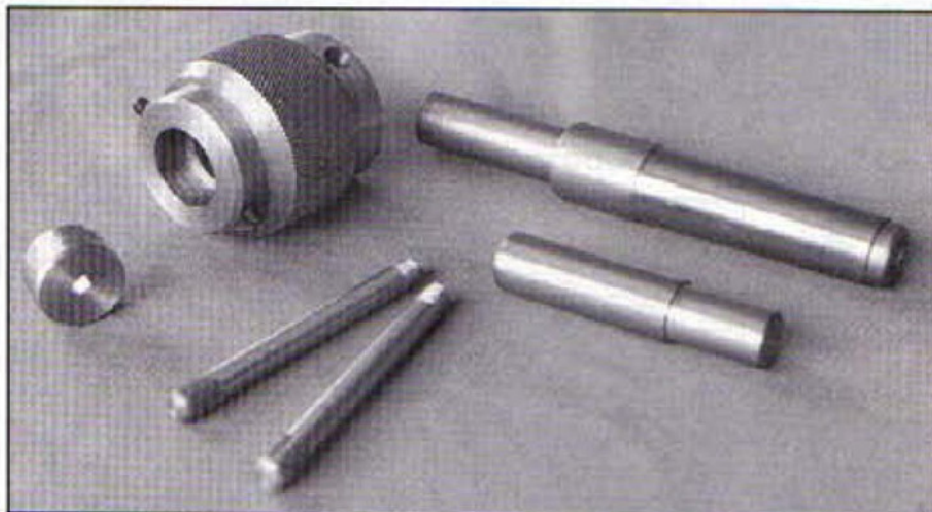
A three way tailstock turret, very useful when making repetitive items in the lathe which require drilling. It avoids the need to continually fit and remove the drill and centre drill.



Adapting the Unimat 3 for screw cutting.

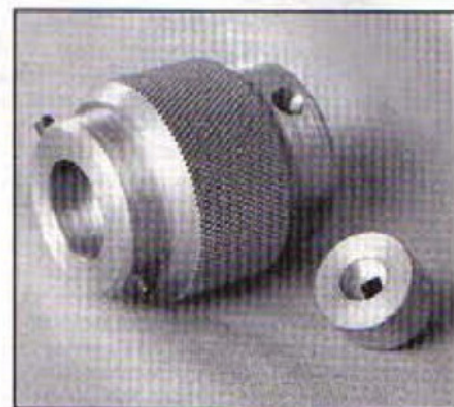
Shaping machines - how to get the best from them.

**AND MUCH MORE
Issue on sale
25 February 1994**



A complete set of parts. More tap holding buttons will be required for other sizes of square tops.

The main body and a tap holding button in close-up.



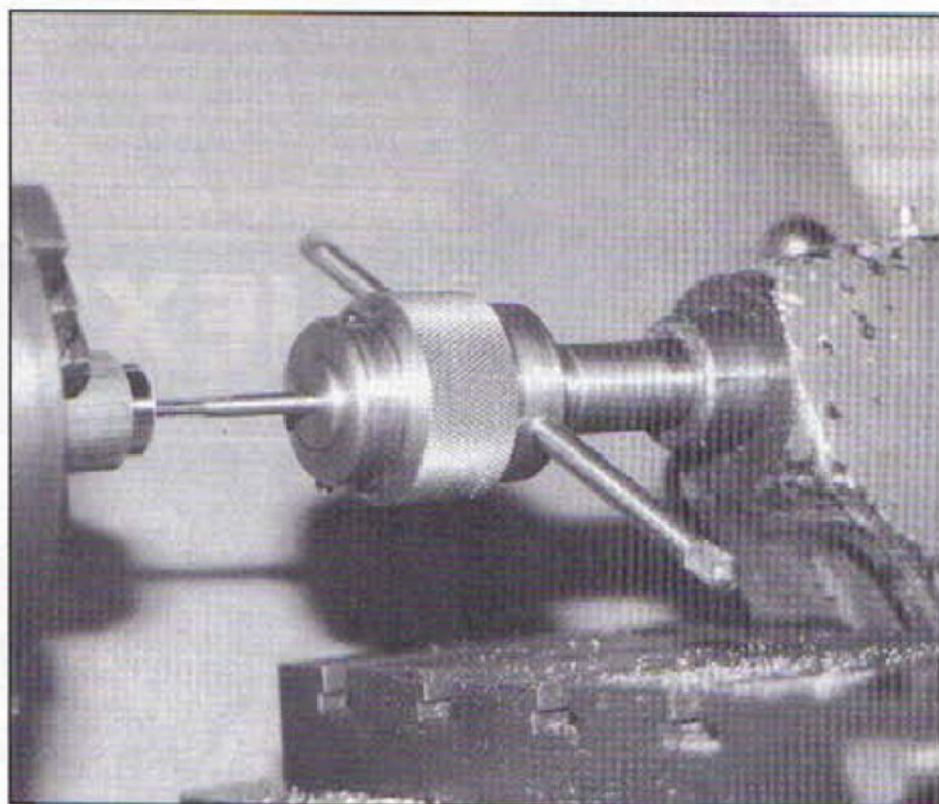
TAILSTOCK TAPPING DEVICE

Commonplace tasks are frequently attempted with less than adequate equipment. As an example, tapping in the lathe, using a normal tailstock chuck to hold the tap and rotating the workpiece by pulling the chuck round by hand is often attempted. For small taps this is very insensitive, and for large taps the drill chuck may not grip the tap adequately. R. McKenzie has made this rather nice tapping attachment for use in the lathe tailstock, but as shown in his photographs it is equally at home in the drilling machine.

Tapping from the tailstock has always been a frustrating task, keeping the tap on centre, rotating the tap wrench and feeding in the tailstock centre to maintain alignment. How many hands do you have! Not all taps have the luxury of a centre at the driving end....

This simple device overcomes most of the difficulties encountered and with an additional guide rod, can be used in the drill press. Dimensions given may be varied to suit particular requirements. I have used up to 10mm taps in the device as shown with no problems.

The main body is turned from a piece of 1 1/4in. round mild steel. The knurling should be medium or coarse, as this provides a good grip for the hand and better feel for the tap with less chance of breakages when tapping small holes.



The tool, ready for use on the lathe.

The hole for the tailstock guide rod is best finished by reaming but boring has proved to be quite acceptable. If you already have a tailstock die holder, then the bore should be made to fit your existing guide rod.

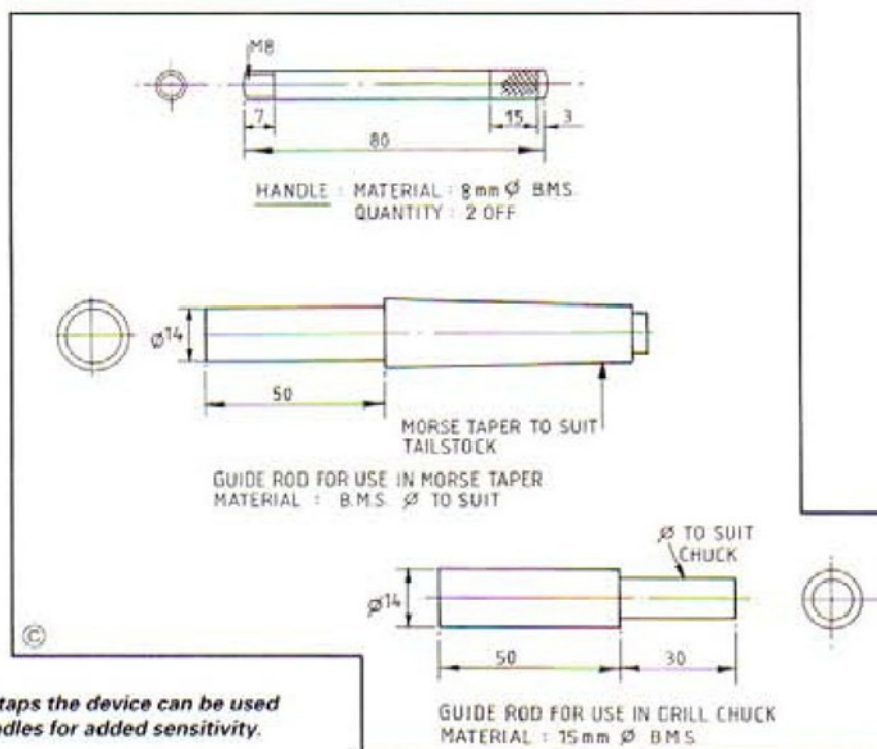
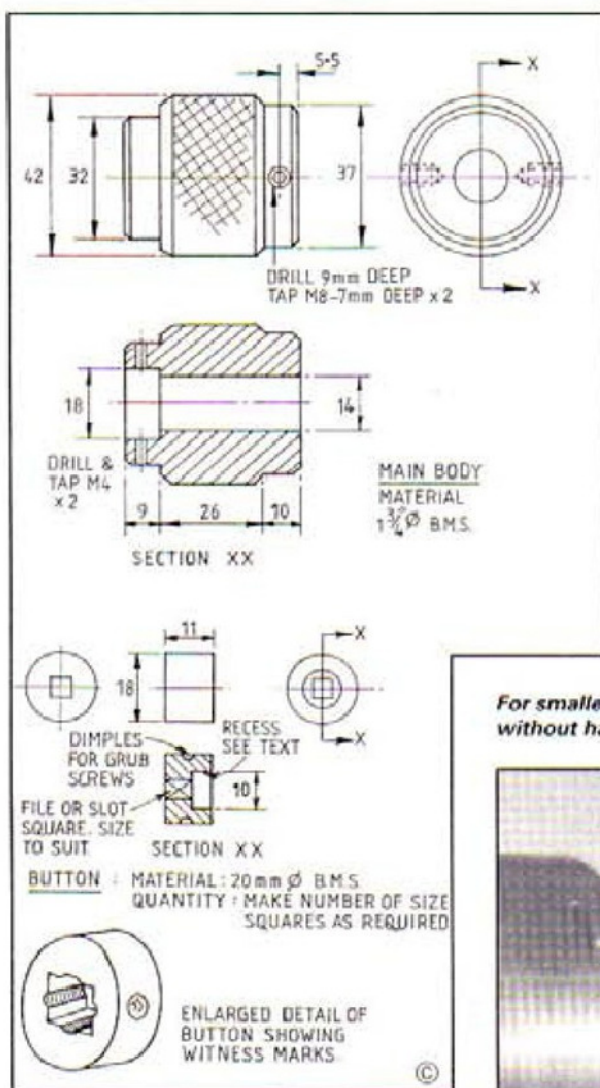
The two holes for the grub screws are drilled and tapped M4 and the holes for the handles drilled and tapped 1/8in. x 40 TPI.

The guide rod needs little comment except that it should be a good sliding fit in the main body with a Morse taper to suit your own machine.

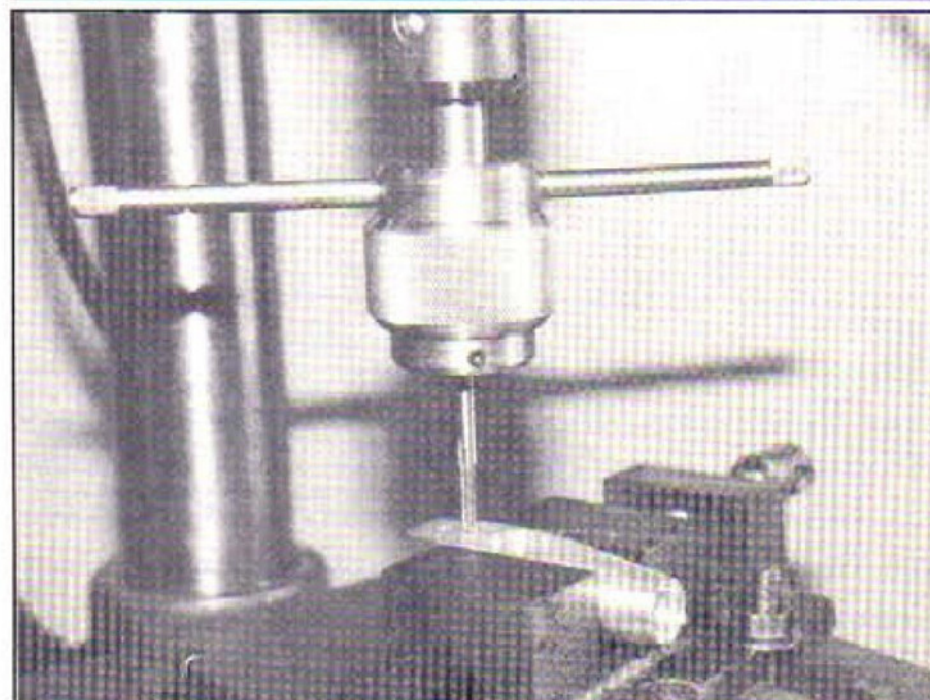
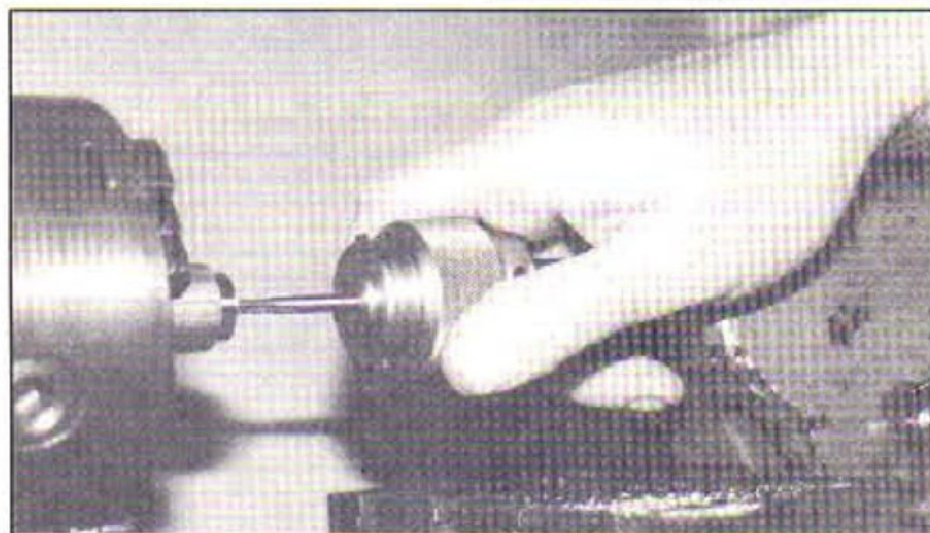
Drill press adaptor

Turn down the guide rod for the drill press to suit your chuck. 1/8in. dia. BMS stock bar is used for the handles and threaded to fit the main body.

Perhaps the most tedious part of the whole job is making the tap driving buttons - one for each set of taps, more if the squares on the heads of your taps vary by an appreciable amount! They are best made from silver steel then hardened. I confess that most of mine were made from odd bits of mild steel that happened to be in the ubiquitous scrap drawer. The square holes can be drilled then slotted out using a



*For smaller taps the device can be used
without handles for added sensitivity.*



'D' bit of correct size in the tool post at centre height and the chuck indexed round at 90 deg. increments. Be warned, internal shaping, by racking the saddle back and forth and putting on small increments of feed is a fairly lengthy process.

All the ones I have made have been done by hand filing. This is not such a laborious task as it first sounds, and is surprisingly quick.

Grip a length of 19mm dia. bar in the lathe chuck, face off and centre. Drill a hole 13mm deep with a drill slightly larger than the across flats dimension of the square of the tap. Machine recess if required. Turn down outside dia. to 18mm and part off at 11mm long. File out hole with small square file to suit tap. With the drilled hole being larger than necessary, a witness mark is left that keeps you accurately on centre. Fit in position in main body and mark through tapped holes for the dimples. Remove and drill.

The buttons should be recessed as shown in the sketch, leaving enough material for full engagement of the length of the tap square.

Before making the buttons, check that the square ends on your taps are concentric with the tap shank. A few of mine are not.

Finally, make sure your tailstock is exactly on centre, in both planes.

*The tool, with a suitable feed rod, is
equally at home on the drilling machine.*

Alan Jeeves gives us an insight into the history of British Standards, and concludes with a very useful list of present day standards that have some relevance to the activities of the amateur engineer

BRITISH STANDARDS FOR AMATEUR ENGINEERS

The familiar kitemark which we are accustomed to seeing on so many of the products which we buy, in itself stimulates confidence in the quality and safety of differing merchandise. This mark has a wide range; from children's toys to motorcyclists crash helmets; it is the endorsement of the British Standards Institution (B.S.I.). It has been with us since 1903, when it was first stamped onto tramway rails.

History of the Institute

The B.S.I. originated in 1901 and at that time only dealt with engineering standards. It was through the endeavours of men like Sir John Wolfe Barry (1836-1918), of Tower Bridge fame, that the British Engineering Standards Association came into being. He was a principal consulting engineer of his time, undertaking railway and dock building works, as well as bridge construction. Being a member of the Council of the Institution of Civil Engineers he was in a position to advocate the appointment of a committee of leading civil engineers. Their aim, initially was to deliberate over the standardisation of iron and steel sections, which up to that time were marketed in essentially non matching sections by a variety of manufacturers. On 26 April 1901 the Engineering Standards Committee was born. The committee's work advanced rapidly in the years that ensued and on May 23 1918 it changed its name to the British Engineering Standards Association (BESA).

"The value of the work of the Engineering Standards Committee is well known"

Winston Churchill, February 1918

The B.S.I. comes into being

It was back in 1902 that the Engineering Standards Committee agreed to incorporate electrical equipment within its standards.

Until 1930 they were still mainly concerned with mechanical engineering. At that time, proposals were put forward by the Association of British Chemical Manufacturers to encompass chemical standards within its province. Once agreement had been reached on this issue, the BESA was re-titled the British Standards Institution; made up of three separate committees, charged with responsibility for Chemicals, Building, and Engineering.

The first of many

The first British Standard (BS.1) was published in February 1903 and covered rolled steel sections. Entitled British Standard Sections it was issued by the Engineering Standards Committee and was supported by the institutions of Civil Engineers, Mechanical Engineers, Naval Architects, Electrical Engineers, and the Iron & Steel Institute.

It contained 9 parts, namely:

- 1) Equal angles.
- 2) Unequal angles.
- 3) Bulb angles.
- 4) Bulb tees.
- 5) Bulb plates.
- 6) Z bars.
- 7) Channels.
- 8) Beams.
- 9) T bars.

If you wanted a copy of B.S.1 in 1903 you could buy it from most bookshops, at a cost of one shilling (5p), or it could be obtained directly from the committee via their (1903) offices at 28, Victoria Street, Westminster, London, SW.

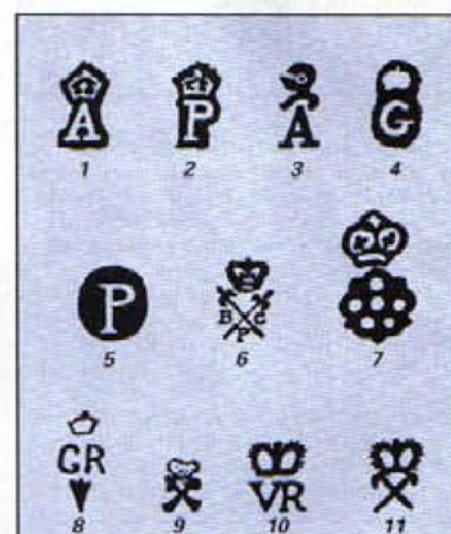
At this time different manufacturers produced varying sized steel sections to embrace the same safe working loads, B.S.1 encouraged them to use the same dimensions throughout the industry for the commonly used sections and succeeded in reducing the number of different structural steel sections in popular usage from 175 to 113. As if this was not exemplary in itself, it further reduced the number of different tram rail sections then in use from 75 to an astounding new total of 5. From the very start British Standards were a huge success.

Past Standards

Even at the beginning of the 20th century standards were nothing new. The London Guild of Goldsmiths stamped gold, silver, and platinum articles as an indication of quality and date of

manufacture, as well as the makers mark. This stamping is known as a hallmark, named after the Goldsmiths Hall in London where stamping took place. (The published lists of such marks provides antique dealers and collectors with valuable reference information up to the present day).

Another of the earliest recognised standards was the firearms proof mark. On 14 March 1637 the Worshipful Company of Gunmakers of the City of London was formed. This consisted of 125 gunmakers who had the right to proof gun barrels by loading them with a larger than normal charge and firing them under controlled conditions. The barrels were then inspected for defects and, if all was well,



Proof marks used on gun barrels, examples from various periods - a representative selection. 1 - 2) View and proof marks from the Armourers Company, the earliest examples. 3) Similar marks used 1650 - 60. 4) Another mark, date uncertain, but seen on guns dating back to 1721. 5) A proof mark used by a private Birmingham Proof House. 6) View and proof marks of the Birmingham Gunmakers Proof House after 1813. 7) Ordnance view and proof marks used in the reign of James I. 8 - 9) Ordnance View and proof marks from a musket dated 1722. 10 - 11). Ordnance view and proof marks dating from the reign of Queen Victoria. 12) A Barrel viewers mark dating from the 18th century. (From, British Military Firearms 1650 - 1850, by Howard L. Blackmore, published by Herbert Jenkins, 1969, SBN 257 65672 3)

they were stamped with the company's mark which consisted of a crown above the letter "A". A geographical boundary was set up which included the City of London and the surrounding countryside within 10 miles of the city boundaries; it was forbidden to sell any gun inside this boundary which did not bear the crown over A mark. However, it must be said that the safety of the shooter was probably not the prime concern for this regulation but the profit of the gun makers the more likely.

Another standard test, the results of which can still be seen today, are on many of the 16th and 17th century suits of armour which are still in existence. There can be found a small indentation on the breast plate which was caused by the firing of a bullet (at the plate) at close quarters. This indicated to the wearer that the armour was of a quality which could withstand gunfire. As a contradiction in terms these standards varied widely depending upon how much powder was used to proof a gun barrel or by how much the ballistics of the firearms differed when testing armour.

Hence in both cases above, these could perhaps be termed as cosmetic, rather than scientific standards.



The man who set the successful standards for British rail track dimensions, George Stephenson.

Real Standards

Many people believe that the first real generally accepted standard was set by George Stephenson (1781-1848) when he adopted the coal cart gauge of 4ft. 8½in. as the standard gauge between the rails on which his railway locomotives would run. Isambard Kingdom Brunel established his own broad gauge of 7ft. on the Great Western Railway. Eventually this was unsuccessful, following legislation, and the 4ft. 8½in. gauge became universal on main line railways throughout Great Britain, remaining so to the present day.

A popular theory for the odd dimension is that today the 4 ft. 8½in. is measured across the running face of the wheel flanges which bear against the insides of the rails. Long before steam locomotives, when rolling stock was hauled by horses or was cable winched by a winding engine,



Another pioneer for a standard rail gauge, Isambard Kingdom Brunel. His idea, which fell by the wayside was the 7 ft. gauge initially installed on the G.W.R. system. This was eventually abandoned in favour of the 4ft. 8½ in. gauge, following protracted Parliamentary wrangling.

the wheel flanges were run against the outside edge of the rails which were 1½in. wide. The 4ft. 8½in. between the inside of the rails added to the 1½ + 1½in. of the two rails totals 5 feet. A much more credible dimension. When the wheels were later reversed on the axles to allow the wagon to negotiate curves better, the rails were simply kept at the same distance apart.

If the railway gauge was the first real standard then Joseph Whitworth's standard screw threads must surely be the second. Whitworth recognised the need for standardisation in the early 1840s and introduced his 55deg. thread angle for all his threads and a standard number of threads per inch for each nominal diameter employed by the engineer. The British Standard Whitworth screw thread became accepted in Great Britain and was much used in the metricated countries of the world. It was even used extensively in Germany until its use reputedly was forbidden by Adolf Hitler in 1938. This thread is still to be found in BS. 949 and BS. 1127 along with its complementary fine, extra fine, and pipe threads. It may be noted at this point that in 1864, some twenty odd years after Whitworth's standard screw threads were introduced, a Mr. Sellers standardised screw threads in America and resorted to a totally different thread form. Model engineers threads are simply the extra fine Whitworth threads, usually 32 or 40 threads per inch but sometimes 26 or 60 also, which were standardised in 1912 (largely by Mr. Percival Marshall) and are now incorporated in the Whitworth Fine series (1950). These are quite different from British Standard Fine series threads, both in form and nomenclature, e.g. ½in. ME should now be described as ½ x 32 WF.

What constitutes a British Standard?

A British Standard is simply logic. It is an accurate and concise definition of what is necessary to guarantee that a material, product, or procedure is suitable for the

use for which it is intended. Five categories of British Standards are generally acknowledged to exist, they are:- glossaries - dimensional standards - performance standards - test standards - and codes of practice.

Glossaries are essential to enhance communication. They can define the terminology which is used in any particular area of technology and it is common to find glossaries incorporated into other categories of standards. In short, glossaries enable everybody to understand what everybody else is talking about.

Dimensional Standards are exactly what the description implies. They control the dimensions of products, etc. within specified tolerances in order to promote interchangeability and replacement of parts without causing major problems. An example is where a set screw can be made to a standard in John O' Groats, a nut can be made to the same standard in Land's End, and they can be fitted together in Manchester with the confidence that the one will exactly accord with the other.

Performance Standards define appropriate levels of functioning for a product or a service; they ensure that the product will offer reliability when in use. An important part of this standard is the coverage of safety products and procedures.

Test Standards can go hand in hand with performance standards and are self explanatory. They lay down the methods of testing a product to ensure its safety and suitability for its intended use. Much has been done, for example, in the area of testing soft furnishings and their combustion which has led to a safer domestic environment.

Codes of practice detail how procedures are carried out and also have a strong accent on safety. The building trade in particular benefits from codes of practice as much of its work is hidden once it has passed inspection, - drains, foundations, cavity insulation are all aspects of a building which the customer may never actually see.

The use of Standards

Standards are of great value to the amateur engineer as well as the professional. A copy of BS. 970 or even extracts from it can be most helpful when selecting which material to use for a job, as this particular standard covers most of the steels which the model engineer will be likely to encounter; with the exception of tool steels having a carbon content in excess of 1%.

BS. 970 may be considered essential when selecting stainless steel grades, specific grades may be important to an amateur boat builder, or experimental engineer needing specific qualities in his choice of material.

Reference to BS. 949 or BS. 1127 may tell you that a ½in. BSW tap or die is identical to a ½in. ME and could prevent the purchase of a duplicate set of screwing tackle. BS. 46 details keys and keyways and the study of it soon reveals that for any given size of bore (or shaft) a standard keyway is recommended. Therefore if you are making a keyed shaft you can then machine in a standard keyway, safe in the knowledge that when you buy a standard pulley to fit the shaft it will be provided with a keyway of the same dimensions as that in the shaft. How many people reading

these words, I wonder, are grateful for the fact that their lathe is equipped with a spindle nose of 1 1/4 in. x 12 tpi. Where can't you get accessories for this lathe. To assist the engineer in identifying a standard, a list of common workshop items and materials is included along with the relevant British Standard in which they are to be found.

Standards of other Countries

Britain was the first country to produce an extensive standards system. The U.S.A. had no such organisation until 1918 when the American Standards Engineering Committee was formed. This was changed to the American National Standards Institute (ANSI) and is now the American Standards Association (ASA).

France formed the Permanent Standardisation Committee in the same year; this was the forerunner of the Association Francaise de Normalisation (AFNOR) of 1926.

The Standards Committee of German Industry was established in 1917 which became the Deutscher Normenausschuss (DNA), and is now Deutsch Industrie Norm (DIN).

An attempt to form an international standards organisation was made in 1926 and the 18 countries, which had by this time introduced their own national standards, met to consider the possibility of international cooperation. Consequently the International Federation of the National Standardising Associations (ISO) was founded. Britain, however, did not join this organisation and it was disbanded in 1939 at the outbreak of WWII. Britain did participate when, in 1946, the International Organisation for Standardisation (ISO) came into being. Many standards in this country are now specified in BS, ISO, or DIN, with some (particularly American pipe threads) specified in ASA.

Standards today

Today, new standards are constantly being introduced in a bid to advance safety and efficiency in industry. Of particular note is the national standard for quality management BS. 5750. This has been adopted as the International Standard ISO 9000 and the identical European Standard EN 29000. More and more household names in manufacturing and the service industries are stipulating that all sub-contractors who wish to be included within their listing of approved suppliers of goods or services must be registered to BS. 5750.

Indeed one police station (to date) in Britain has achieved certification to this standard; thus BS 5750 it is not restricted to engineering or manufacturing; a further standard is proposed in BS. 7850 (total quality management).

It is not suggested that the home workshop owner attempt to secure BS. 5750 registration but lessons are to be learnt from it. If the bar stock which is held by the amateur, no matter how modest, is definitively colour coded or otherwise identifiable, time can be saved when the material is required for use. Mistakes can be avoided in the knowledge that it is the correct grade of material for the job. If everything in the workshop has a place and is returned there after a job has been completed time can again be saved when selecting tools for the next job and the risk of damage to them is reduced. It must be remembered that many model engineers make an hour here and there in the workshop as circumstances allow; this time should not be wasted in searching for odd tools, which "are here somewhere".

Talking of taps (and dies), although not covered by a BS, a recommendation has been published by the B.S.I. *Guidance for metric screw threads and fasteners for use by model engineers (PD 6507 - 1982)*. This lists preferred metric threads for use by these particular users. It is well worth considering.

Conclusions

This concludes my brief look into British Standards, as we have seen, these standards have been largely influenced and instituted by the engineering section of industry. I recall when I had my first introduction to the B.S.I. the then director of the institution was a former engineering director of Ruston and Hornsby, a company well known to model engineers as past builders of fine traction engines and other heavy engineering products.

I hope that I may have influenced at least a few home craftsmen to look up one or two of the thousands of British Standards which have been introduced over the years; perhaps they will make good use of the information contained in them in their own engineering activities.

A good reference point for starting investigation into these very useful publications is a good reference library. (Full details of your nearest set of British Standards can be obtained by phoning 0908 226888 - Ed.)

Extracts, often quoting relevant passages from the standards can often be found in engineering books and publications. Most commendable in my opinion are the staff at my local reference library who have been to me a source of unsurpassed and knowledgeable assistance.

APPENDIX 1

Some British Standards relating to commonly used materials which may be of use to the amateur engineer

Materials	BS No.
Aluminium Alloy - Bar	1474 & 1476
Aluminium Alloy - Sheet	1470
Aluminium Bronze	2033
Brass rod	2874
Copper and brass - Bar	2874
Copper and brass - Sheet	2870
Copper and brass - Tubes	2871
Gilding metal - Bar	2874
Gilding metal - Sheet	2870
Mild steel bar	970
Phosphor bronze - Bar	2874
Phosphor bronze - sheet	2870
Phosphor bronze - Cast	1400
Stainless steel - Bar	970
Stainless steel - Sheet	1449 & 1501
Stainless steel - Light tube	4127
Tool steel over 1% carbon	1407

APPENDIX 2

British Standards apply to tooling, the following may be of interest

Tools	BS. No.
Centre drills	328
Drawings (Engineering)	308
Ear muffs	6344
Keyways (sq., rect., p'lel, metric)	4235
Keyways (sq., rect., p'lel, imp.)	41
Micrometers - outside	870
Micrometers - inside	959
Micrometers - depth	6468
Milling cutters	122
Safety glasses	2092
Screwing taps	949
Screwing dies	1127
Twist drills	328

APPENDIX 3

The address of the British Standards Institution is:- Linford Wood, Milton Keynes, MK14 6LE.



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SMALL TOOL AND MATERIALS STORAGE



An overall view of the tool cabinet – the Formica top was a later addition; even the side is used to store woodworking saws.

Once the workshop is kitted out with various machines, benches etc. a problem arises its ugly head – that of locating and storing the oft used small tools that have been acquired. Very soon another irritation surfaces; orderly storage of metals. We present two ideas by John Pooler which go a long way towards solving this problem

A tool storage cabinet

The photos show a simple tool cabinet made from recycled packing cases. I can now find any tool quickly, and can see at a glance if any are missing.

The cabinet is made from 10mm plywood, although chipboard could have been used. The finish is rough and ready but the design has proved very practical. My cabinet is 26in. wide, 17in. deep and 40in. high. It holds most of my tools with space to spare at the bottom. The sides, back, top and bottom were each made from a piece of 10mm plywood held together at the corners by pieces of 1 x 1½in. softwood. Fixing was with glue and screws (1½in. x No.10 zinc plated). A Formica top was added later.

Each drawer consists of a sheet of the same 10mm plywood and a sheet of 1in.



A close-up of one drawer showing the cut-outs in the plastic to ensure that each tool has its own location.

thick rigid polystyrene wall insulation. The outline of each tool for the shelf was marked out on the polystyrene and cut out with a piece of hot wire. The polystyrene was then glued to the plywood.

The runners for the drawers are strips of softwood glued and screwed to the inside of the cabinet sides. Strips 1½ x 1in. (finished size) were used for the top shelves and 1½ x 1 in. for two shelves near the bottom. The bottom shelf is below a 2½ x 1in. strip, which gives space for storage of larger tools. The strips were set with a ¼in. gap between to give good clearance for the 10mm plywood. The front of the drawers were cut from surplus pieces of veneered chipboard and screwed to 1 x 1½ x 2in. softwood blocks at the front of the plywood shelf.

Small items such as taps and dies were separated within one cut out by spacers made from aluminium sheet (cut from soft drinks cans). The sheet was bent into a number of adjacent U shapes.

The whole cabinet is mounted on castors. A steel frame was welded from ¾in. square mild steel tubing and was screwed to the inside of the bottom softwood frame. This steel frame was drilled to accept castors which were rescued from an old washing machine.

I used masking tape and a ball point pen to make the labels; these are functional but unsightly.

A storage trolley for strip and bar stock

The photograph shows a simple trolley for storing strip and bar stock. The trolley itself is welded up from ¾in. square mild steel tubing. For stability it is slightly narrower at the top than the bottom. The trolley is mounted on sofa castors from a DIY store which are welded to the frame. Strong castors are needed as the weight of the loaded trolley is more than 1 cwt.

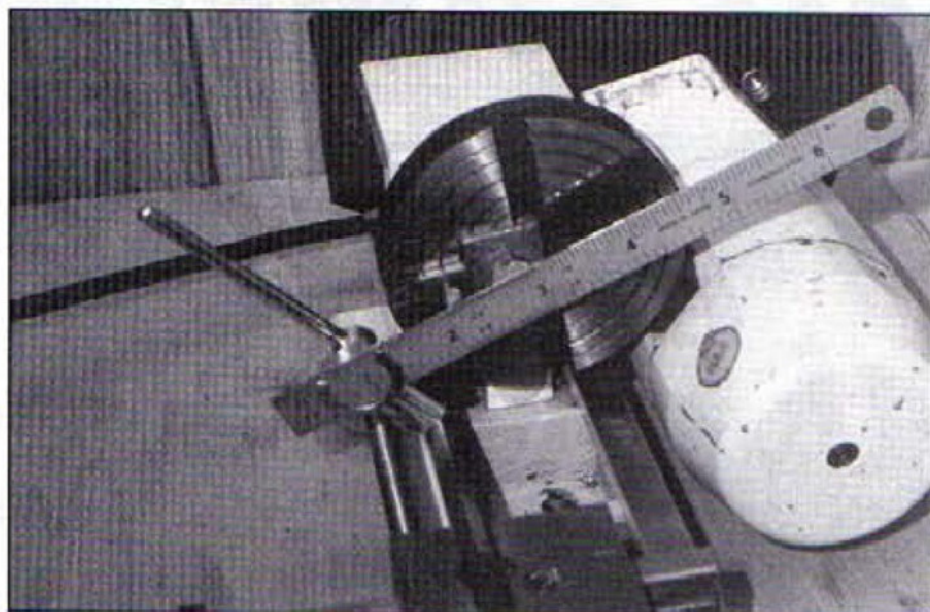
I made the trolley 16in. long; 16in. high and 11in. wide at the bottom, tapering to 9in. at the top. Stock material is stored in plastic pipes for easy access. I used a variety of sizes between 1½ and 4 inches. These were cut to a uniform length of 20 in. and stacked with the smaller sizes between the larger to make best use of the space.

I have found the storage trolley useful. Material is easily accessible and the trolley can be wheeled out when sweeping the floor.



The functional and effective metal storage trolley.

A MAGNETIC POST



J.H. Frost suggests an easy and economical approach to obtaining small magnets and offers a design using one of these in a magnetic base scriber block cum rule holder. The tool made in this article is in constant use on the author's Unimat 3 lathe; the design can be adapted for other lathes of whatever size

I have had very little experience of using a lathe; at one time I was given a small amount of instruction, and so was not entirely ignorant when I purchased my Unimat 3. The lathe I had used earlier was much larger and had a flat bed on which I was taught to position a scriber block to assist with centring work. The Unimat had no surfaces suitable for such a device and this project arose from my desire to put into practice the instruction I had received. It is a simple magnetic post which can carry a scriber holder. The base can act as a centre height gauge for small lathes; and as a rule holder using a fairly simple extension. Its usefulness is not restricted to the Unimat nor, I am sure, are the uses to which the post can be put confined to my ideas.

The machining is not difficult and can be completed on the Unimat 3 lathe. No great accuracy is required and I found the process of machining the easily worked aluminium or brass a relaxing experience which taught me a great deal about using this small lathe. Apart from a piece of 1/2in. round bar, I was able to purchase everything that was needed to complete the post and scriber from a DIY store, or a well stocked model shop.

I found a suitable magnet in a cabinet door catch at my local DIY store. It

The post being used on the Unimat 3 for which it was made. It will of course suit other similar size lathes and also larger ones.

comprised a small block of magnetic material sandwiched between two almost half round pieces of ferrous metal. The metal pieces protrude a little beyond the block so the result is a horseshoe magnet, almost round in section.

The magnet can easily be affixed in a hole bored in a piece of 1/2in. bar, which is



Being used as a rule holder on the surface plate.

about the width of the rear bearer of the Unimat. The catches come in a package of two but are not expensive; I am sure the other will be used. I set the magnet into a piece of aluminium and used steel for the post but, when making an improved version, I decided to use brass throughout. I hoped that brass would act as a better barrier to the magnetism than does the aluminium and avoid accumulating any ferrous swarf that happened to be in the vicinity. In fact there is little, if any, improvement of this shortcoming but, at least, the post no longer becomes magnetic.

Construction

The base is made from 1/2in. dia. non ferrous stock held in the three jaw chuck. Face off the end; the cavity to house the magnet is drilled and bored to suit the magnet. When making the original base a 2.5mm hole was drilled to a depth slightly exceeding the planned height of the base. I opened this out with a 6mm drill to a depth where the point of the drill reached what was to be the limit of the cavity. Finally, I used an 8mm drill, the largest my tailstock chuck would hold. This was followed by a small boring tool to open the hole and flatten the bottom of it to a size that enabled the magnet to be slid in until its outer end was just inside the rim of the cavity. The three jaw chuck was removed from the lathe, still holding the workpiece; the swarf cleaned out, using the 2.5 mm drill, to ensure that the small hole was clear. With the chuck replaced and an M3 tap in the drill chuck the hole was tapped to a depth beyond what would become the top of the base.

Up to this time the workpiece had been set as far as possible into the chuck, much of the boring and the tapping having taken place within the chuck jaws.

A mandrel stop

I have a mandrel stop made from an M6 bolt about 100mm long with about 30mm of thread. I had cut off the head and stretched a rubber tap washer, which I had reduced in diameter so that it just entered the mandrel, over the plain shank. A nut can be adjusted to allow a required amount of bolt to protrude from the mandrel and will centre itself in the mandrel chamfer. A second nut at the extremity of the bolt will prevent a workpiece from being forced further into the chuck than is desired.

Use of the stop

I unscrewed the chuck, inserted the stop and arranged matters so that a little more than the length of the base protruded from the jaws. The workpiece had been marked at its position against the number one jaw and was realigned at that position. I took a very light skim along the length of the piece, just enough to give it a good finish, and, using a parting off tool, cut a short neck at what would be the top of the base. This was partly for decoration; it also removed some weight and kept the centre of gravity low. The base was then parted off.



The source of the magnet used.

First revision of the original plan

I had thought about making a collar to slide onto the post to act as a centre height gauge but, when planning this in detail, I realised that it was necessary only to increase the height of the base slightly to enable it to serve this purpose. I made the revised base to slightly exceed the new dimension, to be brought to exact centre height later and offset the post to the rim of the base to reduce any obstruction that it may have presented. The new base was made in much the same way as the original but the offset hole for the post was drilled and tapped as the final operation, centring the new location in the four jaw chuck.

The post

The post was a length of $\frac{1}{8}$ in. round brass rod, purchased from a model shop. Its end was reduced to 3mm and a small groove turned at the shoulder for the thread to run into. This to ensure that the shoulder would seat perfectly when the post was screwed into the base. I threaded the reduced end M3 and cut a fairly wide chamfer at the top of the post. This is needed if the scriber holder, described later, is to be constructed.

When assembled the post should stand square to the top of the base and the whole should be perpendicular to a flat surface on which it is stood. If the base is to be used as a centre height gauge, fitting the post is best left until after the magnet has been installed.

Fixing the magnet

To fix the magnet in the base an implement of wood or plastic is needed, thin enough to pass between the two metal parts of the magnet assembly and narrow enough to enter the bored hole in the base. The post can be held, inverted and suitably protected from the jaws, in a vice. A quantity of Araldite Rapid is mixed, 1 in. each of adhesive and hardener is ample, take care to obtain a good, even mix. Keep a small cloth dampened with white spirit handy and spoon some adhesive into the base with the implement. It is best to insert

several small blobs to place it at the bottom of the bore avoiding entrapment of air. About a quarter of the bore should be filled and the magnet assembly pressed into the adhesive. The centre block of magnetic material will probably be forced up and this must be pressed down using the implement. A certain amount of jockeying will be required until the adhesive has seeped up around the sides of the magnet, allowing the assembly to sit on the bottom of the bore with the centre block well below the two metal pieces. Any adhesive that spills over the edge of the bore can be removed with the cloth. The top of the magnet should be just below the rim of the bore but the bore should be filled with adhesive. I left the adhesive to cure for 24 hours before putting the post back in the three jaw chuck and gently facing off the base until the two metal parts of the magnet were reached and themselves lightly faced. During this process the post itself, which will now be firmly fixed to the base by adhesive penetrating its thread, is accommodated in the lathe mandrel.

When placed on a flat ferrous surface it should stand perpendicular and should be held firmly by magnetic attraction.

A base that is to be used as a centre height gauge can be brought to its final dimension once the magnet has been fitted. A scriber, set in the three jaw chuck, is checked for truth with a centre brought up on the tailstock. The base is then placed on the saddle and brought up to make contact with the scriber. By twisting the



Close-up view of the parts which make up the scriber and rule holders.

base against the scriber a line is scribed at centre height. The base can be faced off to this mark. The hole for the post can then be drilled and tapped and the post fitted.

Scriber holder

The main reason for building the post in the first place was to support a scriber holder to aid centring work pieces in the four jaw chuck. I made such a holder but my design was bad as the screws tended to lock making accurate adjustments difficult. This made me realise how little room there is on the Unimat to work with this type of device, especially when the toolpost and tool are in place. I also realised that I was not scribing with the tool, merely using it as a pointer to aid centring and decided that I needed a pointer that would stay in any position at which it was set, but for

QUICK TIP

Clearing swarf from the lathe bed is a mucky business; when it's wet with cutting oil, it's worse. A scoop can be made quite simply by using one of those empty plastic bottles from the mineral water firms.

The rectangular type is best. Leave the screw cap in place. Starting at about 4in. from the shoulder, cut the bottle on the short face at about a 45 deg. angle and discard the bottom end. Glasspaper the rough edges and you have a strong scoop which will pick up all the small coagulated swarf. This not only recycles the plastic but makes the scoop disposable if it breaks, though it is quite strong and durable.

Geoff Hunt

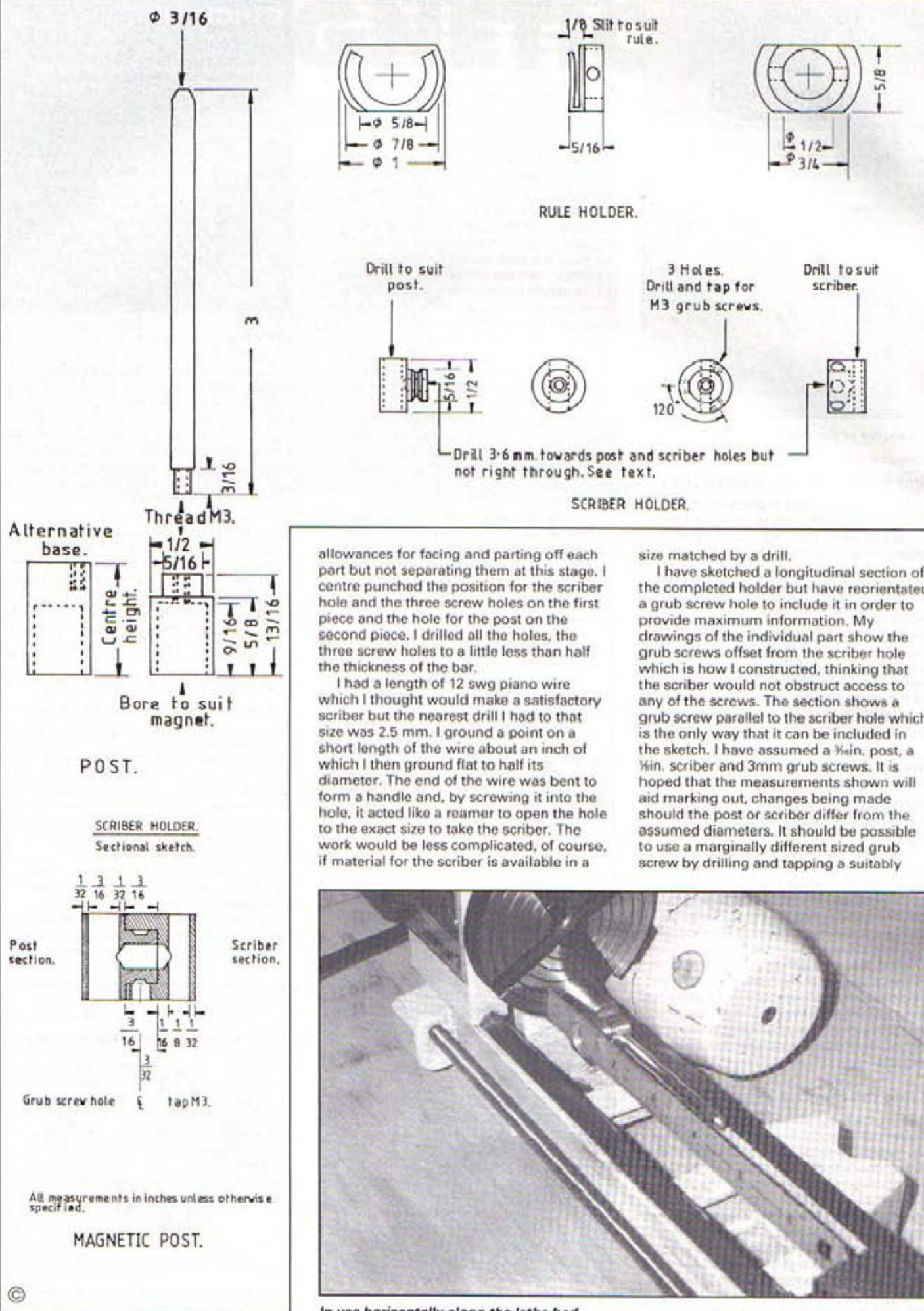
which there was no need for locking facilities.

My idea was to use two ball bearings with a spring between, one impinging on the post, the other on the scriber. The smallest ball I could buy was $\frac{1}{16}$ in. dia., two making $\frac{1}{8}$ in. and with the need for a spring between them I was going to have a fairly hefty piece of metal supported by my post. I decided to try an elastic material to exert pressure on the post and scriber and, after some experiment, decided on a short piece cut from an "O" ring. This is held under pressure within the holder and imparts the friction necessary to hold the components in the position in which they are set. The holder, held together by three grub screws, is made in two parts that are able to rotate, one against the other, the ease of rotation being controlled by the tightness of the screws.

I have made a short length of square bar, an exact fit in the slots of the cross slide and milling table. This has a small depression in its top, made with a centre drill; it is equidistant from the slot sides. Using the mill/drill attachment I can set a drill point to locate in this depression when the quill is lowered. After removing the bar from the slot a round bar supported by the slot edges, but of too large a diameter to fall into the slot will be accurately cross drilled when the drill is operated. In considering the holder I decided to make the part that would hold the scriber first to be followed by the part that would be located on the post. I set out the work by marking the ends of the two pieces along a piece of $\frac{1}{16}$ in. round brass bar making



The complete set of parts.



allowances for facing and parting off each part but not separating them at this stage. I centre punched the position for the scriber hole and the three screw holes on the first piece and the hole for the post on the second piece. I drilled all the holes, the three screw holes to a little less than half the thickness of the bar.

I had a length of 12 swg piano wire which I thought would make a satisfactory scriber but the nearest drill I had to that size was 2.5 mm. I ground a point on a short length of the wire about an inch of which I then ground flat to half its diameter. The end of the wire was bent to form a handle and, by screwing it into the hole, it acted like a reamer to open the hole to the exact size to take the scriber. The work would be less complicated, of course, if material for the scriber is available in a

size matched by a drill.

I have sketched a longitudinal section of the completed holder but have reorientated a grub screw hole to include it in order to provide maximum information. My drawings of the individual part show the grub screws offset from the scriber hole which is how I constructed, thinking that the scriber would not obstruct access to any of the screws. The section shows a grub screw parallel to the scriber hole which is the only way that it can be included in the sketch. I have assumed a $\frac{3}{16}$ in. post, a $\frac{1}{16}$ in. scriber and 3mm grub screws. It is hoped that the measurements shown will aid marking out, changes being made should the post or scriber differ from the assumed diameters. It should be possible to use a marginally different sized grub screw by drilling and tapping a suitably

sized hole at the indicated centre line.

The most accurate measurement of the part that holds the scriber is the depth of the bore. It must extend beyond the screw holes but must not break into the scriber hole. I bored it a little shallow and concentrated on getting the diameter right, then took it to its final depth in the process of flattening the bottom and obtaining a really sharp corner on the internal diameter. A 3.6 mm drill was held in the tailstock drill chuck to drill towards the scriber hole just to the extent that a pip of metal could be seen in the hole surface. This was cleared with the makeshift reamer but if such a device is unnecessary the drill that had been used to form the scriber hole would be used. Work with the 3.6mm drill was continued until about half the length of the drill point protruded into the scriber hole. All that remained to complete the piece was to tap the three grub screw holes M3 and part off.

I faced the end of the bar to commence the second piece, leaving it a little longer than indicated by the drawing, and again used the 3.6mm drill to drill towards the post hole using the same procedure as that carried out on the scriber holder. The diameter of the piece was then reduced, up to $\frac{1}{2}$ in. from the edge of the post hole, until the bore in the first piece could slide over the reduced diameter and revolve freely but without slackness. The large diameters of the two parts did not quite meet because of the extra length left when facing the workpiece. The correct length of the reduced section could now be marked by measuring from the shoulder and the piece faced back to a perfect fit with the scriber holder.

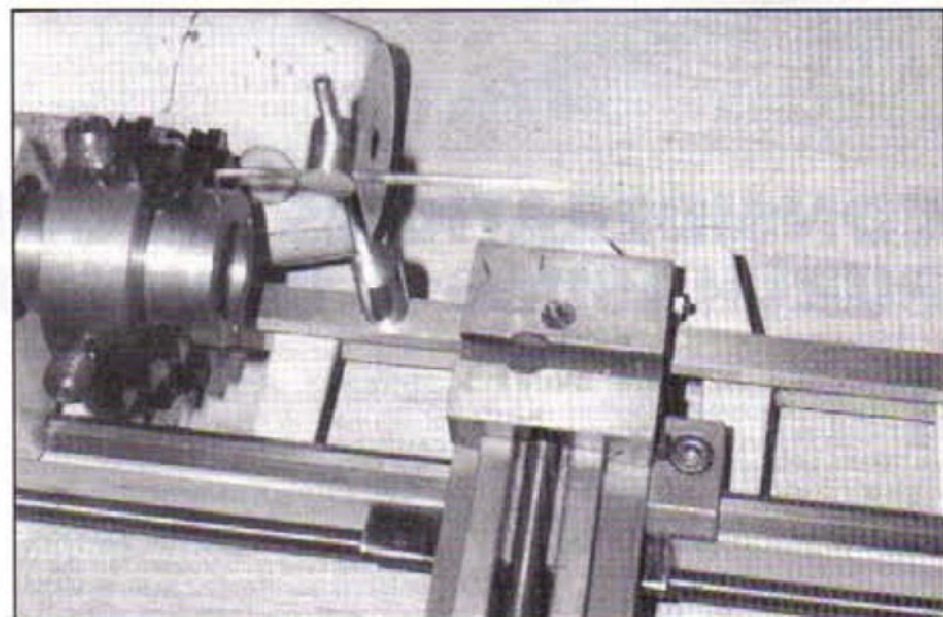
A groove had to be turned on the reduced diameter of the workpiece and the scriber holder was fitted to enable the groove position to be marked through one of the screw holes. A screw cutting tool with a 60deg. included angle was used; it had to be very small to cut close to the shoulder. The groove was kept quite shallow to permit a later adjustment, if necessary, to obtain a correct fit of the two parts. After advancing the tool a small distance it was traversed a little towards the shoulder to flatten the bottom and to offset the groove slightly so that, as the screws were tightened, they would draw the two parts together. I bought a pack of four tiny M3 Allen grub screws, only about 3 mm in length, from the model shop; they are used to secure sprockets to shafts. After checking that the screws held the parts together correctly and allowed the scriber holder to revolve smoothly the workpiece was parted off.

Some experimenting was needed to arrive at the correct length of "O" ring. The diameter of the ring material was about 3.6mm and a fairly large diameter ring was used so that, when cut, the material was not too curved over a short length. The objective, of course, is to have the "O" ring material exert sufficient pressure on the post, at one end, and the scriber at the other to hold the position set but allowing smooth sliding adjustments to be made.

When first assembled the two parts of the holder should be held slightly apart by the "O" ring material. This gap is closed by pressure from the fingers and the position held by turning the grub screws into the groove. They should be just tight enough to hold the parts together and exert

sufficient pressure to ensure that the parts remain in any position to which they are rotated. It should be possible to push the holder onto the post relying on the chamfer at the post top to compress the material. The point of the scriber should serve the same purpose when fitting it to the holder.

I mentioned earlier that I had used 12swg piano wire to make the scriber. Fairly long, gradually tapering points were ground at each end as these have a better appearance than short, less acute points. It should be born in mind that as the diameter of the scriber decreases so does the grip of the "O" ring material. My own scriber was made from 4in. of wire with $\frac{1}{2}$ in. bent at a right angle at one end.



Being used as a scribing block on the lathe.

The rule holder

I had planned to make a rule holder which would replace the scriber holder and would hold a rule parallel to the surface to which the post was attached. Whilst making the scriber holder it occurred to me that it would not be difficult to combine the two functions so that the rule could be set at any height, to the limit of the post, and its angle varied to best suit the measurement involved. The rule holder needed only a collar that fitted around the scriber holder to a depth that enabled it to be fixed in place by a pin passed through holes in the collar and the scriber hole. The holder is simply a clip into which the rule is fitted and could probably be made from sheet and soldered to a suitable collar. In my case, I had started this project to gain more experience of using the lathe and decided to make it as far as possible on the machine.

I made the piece from a slice cut from 1in. dia. brass bar. Before cutting off the slice I drilled the hole that was to take the pin to secure it to the scriber holder. The slice had to be a little thicker than the finished piece to provide material for the chucks to hold in a manner that permitted machining to be carried out. Provided both ends of the slice are reasonably flat and at right angles to the bar a piece $\frac{1}{2}$ in. long should do but the steps of chucks vary and it is advisable to plan the work in advance.

QUICK TIP

If you are like me, not getting any younger, you may find yourself looking at dimensions on drawings frequently as the memory is not what it was; the inevitable result is greasy drawings. To help get over this, buy a tin of Chalk Board paint and apply it to a smooth surface adjacent to the machinery centre. Once its there, you can chalk up the dimensions and a rough sketch if you wish, so you can refer to it as needed. Another point is that you can sketch as big as you want. Whatever you do, make sure you rub out old dimensions or you'll get some pretty odd results

Geoff Hunt

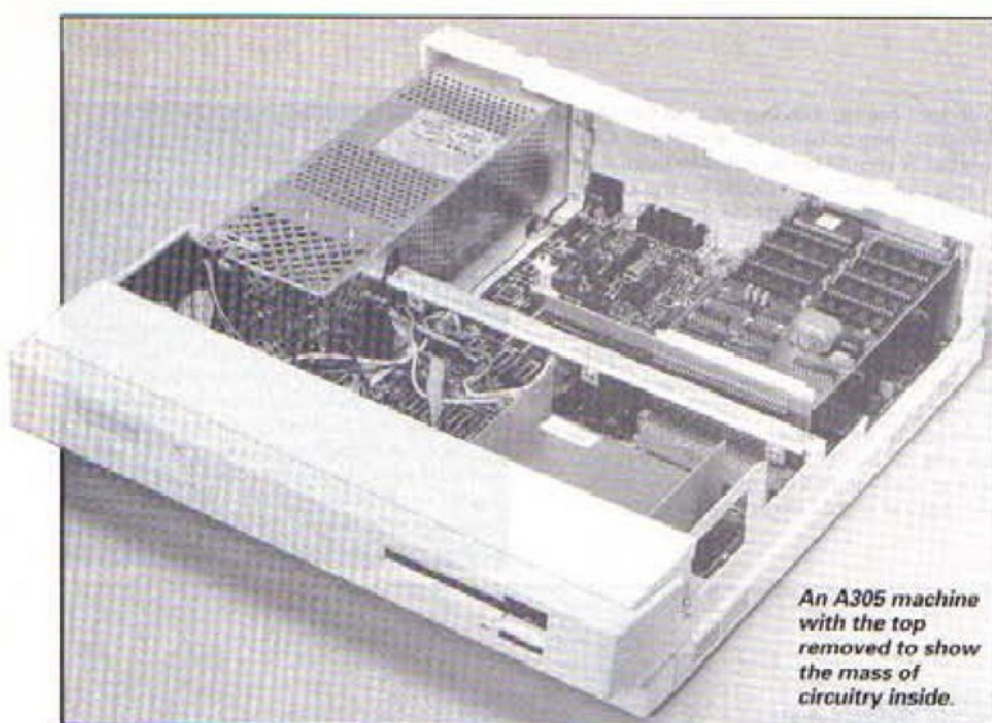
The work was held by reversed chuck jaws, first to face off one end, and then, with the piece reversed in the chuck, to turn the collar and bore it to a fit with the scriber holder. Whilst the large diameter was still fairly thick I held it edgewise in the four jaw chuck and faced away the material to leave flats at top and bottom. The piece was then held, by the collar, in the three jaw chuck to machine the arms. The piece was first faced back to its final thickness and then what would have been a ring, had it not been for the shaping of the flats, was machined to stand proud of the surface. I imagine a slitting saw could be used to complete the arms but, as I do not have one, I created the slot to hold the rule with a junior hacksaw. This left considerable cleaning up to be done to obtain a reasonable finish before the arms were finally bowed to provide a spring grip on the rule.

The scriber could be used to hold the device in place but, after considering the sharp points at each end, I decided to make a pin from the piano wire with a bevel at one end and a small knob at the other to perform this function. This is not included in the drawings, but can be seen in the photograph of the complete kit of parts.

Final note

When the tool is not in use make sure that it stands on a ferrous surface, or use a ferrous washer as a keep.





An A305 machine with the top removed to show the mass of circuitry inside.

Michael Oppenheim is a professional computer tutor. In this article he sets out to describe the ideal computer for use with a CAD system. Whilst he acknowledges that in a brief article such as this it is impossible to more than skim the surface of the subject, he hopes that readers who go in search of a computer will have a better understanding of what is required to meet their needs

CONSIDERATIONS BEFORE PURCHASING A COMPUTER FOR CAD

This article is presented with some hesitation, and for two reasons. Firstly adequate treatment of the included topics is impossible within the scope of a single article; the treatment presented must accordingly be to some degree superficial. Secondly, both hardware and software available are changing - for the better - at an unprecedented rate; and the corresponding price changes are not necessarily upwards. The objective of the article aims at no more than the provision of a minimal background on which the reader may base further enquiries.

CAD

Already we have used a technical term. The terminology itself can prove a serious obstacle to newcomers attempting to get to grips with computers. CAD is one of many acronyms used throughout computing and it refers to Computer Aided Design. The editor of *M.E.W.* prefers to call CAD - Computer Aided Drawing.

Computer specifications

At this stage don't think about money. Think about specifications. It's very tempting to purchase cheap equipment. But if it won't do the job, then however good a deal you may have made, the money will be wasted. Don't buy a mini when you'll need a van.

I'll write the conclusion to this article now. It may be incomprehensible at this stage but all will be clarified as we go through the article. In my opinion the minimal equipment which should be purchased is a 386X computer with 2 Mbyte of RAM, an 80 Mbyte hard disc, and a good quality 14in. VGA colour monitor; preferably with a maths co-processor. A 486X is better than a 386X. 4 Mbyte of RAM are better than 2 Mbyte. More than 80 Mbyte in the hard disc is advantageous. But if the monitor is

bigger than 14in. it is not necessarily better. For with monitors it is quality of picture not size which counts. Don't be misled by "windows": you don't need it and can always add it later. A paragraph on windows is given towards the end of the article.

And then there is the printer. Everything will look beautiful on the screen. But the screen is like our thoughts: beautiful while we are dreaming but nothing remains when we switch off. I recommend either a 21 pin DMP printer or an ink-jet printer; the subject is discussed in greater detail later.

But I won't name names! If you're new to computing then either buy through a local dealer who can be trusted to supply support; or study the market for several months with the aid of the magazine named later or put yourself in the hands of an experienced and qualified person.

Some basic definitions

In order to understand what we are getting into, it will perhaps be helpful to define some of the terms relating to the equipment; so that you have a clear understanding of what you are getting when you eventually decide to invest.

Hardware

The machine, the printer, the monitor, the keyboard, the mouse if we have one. Anything solid which can be touched. Monitor means screen. So why don't we say screen? Good question, but we soon get indoctrinated into accepting jargon; we used to call the monitor the VDU, which is even worse.

Software

The programs which allow the computer to do what we want it to do. Some of it we buy additionally to the computer, such as a word processing package or a CAD program. But there is a lot of software

already built-in to the computer without which the monitor and printer could not interact with the computer.

Media

Disposable objects which hold either software which we buy, or the results of our work using that software. Floppy discs are the only media commonly in use today. There are two standard sizes: 5¼in., the original floppy size; and 3½in., smaller, more robust, and actually containing more storage space.

A useful analogy for understanding the terms hardware, software and media is a musical disc - or cassette - player. The player is hardware; the discs or cassettes are media; and the music itself is the software.

Backing up

Copying all the work which we produce onto floppy discs. Also the one-time preparation of spare copies of the programs we have purchased.

Operating System

Special software which contains all the instructions we need in order to control the computer. To some degree we can replace the operating system supplied with the computer to another of our choice. The operating system is often called DOS. DOS is usually, but not necessarily, already installed on new computers. The latest version is MS DOS v 6, although MS DOS v 5 is standard at the time of writing. If Windows is installed then it should be version 3.1, or later should it have been updated when you come to purchase.

It is fair to say that one of the main difficulties which beginners encounter is handling the computer's operating system. Learning how to operate a computer in general is quite distinct from learning how to use a CAD program. A summary of the

principal DOS operations with which every computer user should be familiar is given later on.

The three worlds of personal computers

We should be aware that the universe of personal computers is made up of three distinct worlds. Firstly comes the world of the Macintosh computer, made by the single American firm of Apple. Macintosh computers are arguably the best and probably the best suited for CAD. They are much more popular in the U.S.A. than in Europe. However I cannot recommend that readers of this magazine buy one. The Macintosh is a little more expensive but by an ever decreasing margin.

The second world is that of the so-called IBM compatible computers. This article will refer to no other. The IBM compatibles have an adequate number of CAD packages available covering a broad range of quality and price. The amount of general software, some of it of excellent quality, is enormous. IBM compatibles are the obvious choice for most users. However, architects and engineers, for whom CAD is the prime professional application to which their computer is dedicated, should look very seriously at the advantages which the Macintosh can offer.

The third world contains all the rest. Some excellent computers are included, especially for the playing of games. Beware particularly of the temptation to buy a computer produced specially for word-processing. Any computer can be used for word-processing (WP); it is necessary only to buy a WP package and feed it in. Some very attractive word-processing computers do not use standard DOS and could not be used with standard (if any) CAD packages. Your computer must be IBM compatible - if not a Macintosh!

Computer Memory

No intelligent discussion of computers can take place without a clear understanding of what memory means. Unfortunately the same word is used with differing meanings in different contexts. There are different sorts of memory, and each involves different terms.

We shall look in turn at RAM, the hard-disc, and floppy discs.

But just to make things difficult, there's also ROM, which sounds like RAM, and I'd like to get that out of the way. We don't need to be concerned about ROM when we select our computer but it is worth knowing what it is. Here goes.

The ROM

When we turn the computer on, something happens. Lights flash, the hard disc whirrs, the screen lights up, and messages appear. An entire system is working even though all we've done is to switch the computer on. The computer has what I like to think of as its instincts. It knows how to convert key strokes into characters on the monitor; it can read from its hard disc, or copy onto floppy discs. All this basic fundamental activity is possible because of specialised software which is provided by the computer manufacturer. And this specialised software is stored permanently within what is called the ROM. ROM stands for Read Only Memory, and we need know no more than that it exists.

The hard disc

We must have one, and the bigger the better. The hard disc is our filing cabinet. The hard disc holds all the programs that we use regularly. It will also hold as many of our drawings, correspondence, data etc as we like. When we buy a CAD program then it will be supplied on one or more floppy discs. But it is not practical to work directly from floppy discs. We firstly, but only once, copy everything from the floppies onto the hard disc. Thereafter the computer can run that CAD program instantly from the hard disc; we need but issue a single command. The original floppies are no longer needed; unless it becomes necessary to re-install the program. Anything and everything previously stored within the hard disc is easily and swiftly available for use.

The hard disc is also used to store the pictures which we draw using our CAD program. We need to learn how to organise the hard disc into distinct areas, like drawers of a filing cabinet, otherwise chaos soon ensues. See *DOS Activities* below.

Whenever the computer is turned off, everything stored in the hard disc remains intact. That is its major virtue. The danger is that the hard disc might become damaged; in that case we stand to lose an awful lot of information! For this reason regular backing up of the hard disc contents is *essential*! The backing up is done onto carefully marked floppy discs.

The RAM

Think of a draughtsman's work table in a drawing office. Imagine a piece of paper spread on that table and the drawing that he's making. This is the work in hand. The bell goes at 5 o'clock. The table is cleared and the drawing filed in the filing cabinet.

In computer terms the filing cabinet is the hard disc. We can come back tomorrow and take out the drawing, exactly as it was at 5 o'clock, and continue working on it. But whilst we're actually working the drawing is on the table. The memory used to store the drawing while we are working on it is called the RAM; Random Access Memory. The more RAM we have then the more efficiently can the computer work. But we must be aware that everything we have been working on - perhaps a complete new drawing - will be permanently lost from RAM every time we turn the computer off. This is as though all drawings left out on

the drawing office table after 5 pm are thrown away by the cleaner! So we must save our work into a permanent memory before switching off the computer. We firstly save it into the hard disc, knowing that the hard disc retains its content after the computer is switched off. Then we copy the RAM contents into floppy discs.

Units of memory

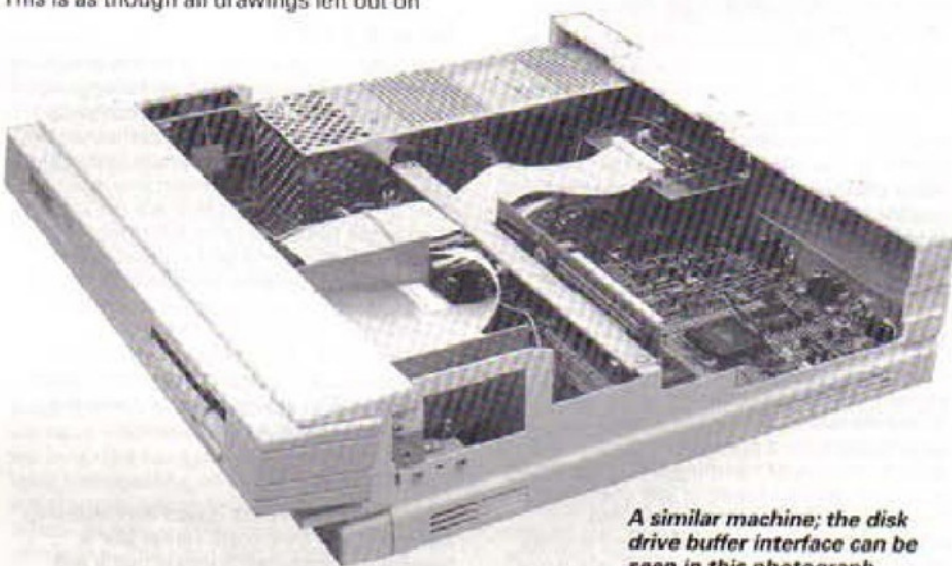
We shall be a little technical but not entirely accurate. Memory size is measured in so-called kilobytes (K) and megabytes (Mb); there are approximately 1,000 K in 1 Mb. Floppy discs are available with differing storage capacities. Commonly used floppies possess 1.2 or 1.4 Mb of storage capacity.

1 byte (1/1000 K) is the unit of storage taken up by a single character, such as X. The whole Concise Oxford Dictionary can be stored in about 5 Mb of storage space. Text is very economical of storage. Drawings (graphics) are not.

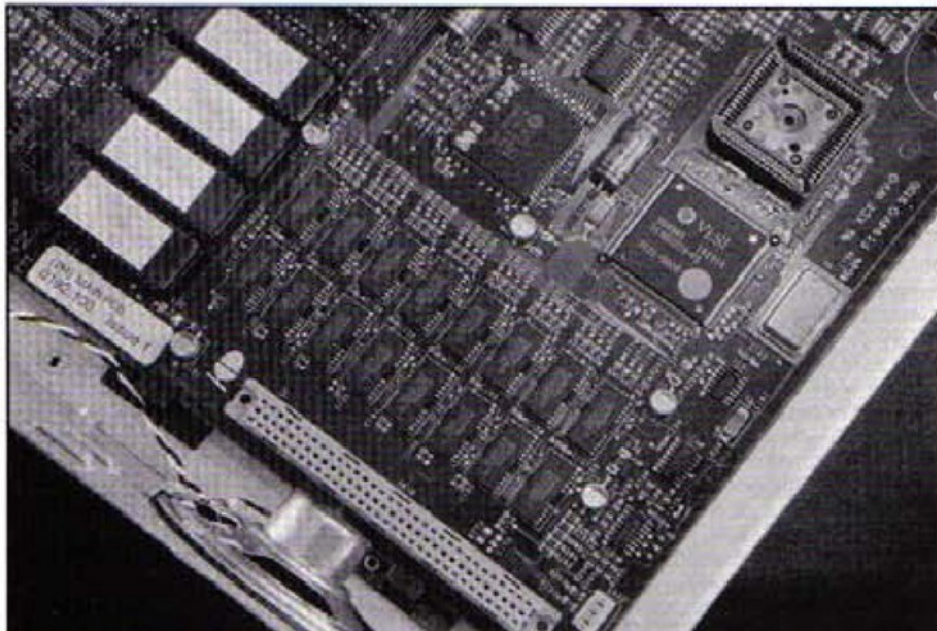
All computers have 640K of RAM; that is the minimum. To be able to handle memory-hungry drawings, however, that is not enough. This is one of the reasons why we should look for a minimum of 2Mb of RAM memory. A smaller RAM may not prevent us from drawing, but everything will proceed very slowly. With restricted RAM space the computer has to swap bits of the drawing in and out, just as a draughtsman would have to manipulate a large drawing spread on a small table. Overall performance will be unsatisfactory with too small a RAM. A further reason for installing a larger RAM in our computer is that most modern programs, not only CAD, are so sophisticated that they will not operate efficiently without it.

Computer Speeds

The speed at which our computer operates will be measured in Mhz, read megahertz. 8 Mhz is very slow; 16 Mhz is both twice as fast and the minimal acceptable speed. The recommended 386X type computer (see below) will have an operating speed of 20 or 25 Mhz. It is no longer a great extravagance to buy a 33 Mhz (or faster) machine: the price differentials are dropping at an impressive rate of hertz!



A similar machine; the disk drive buffer interface can be seen in this photograph.



They talk about ROM and RAM. ROM is top left of this picture, RAM is the array of double chips below it, and the vacant plug top right is for a maths co-processor.

Computer Types (within the IBM compatible world)

The classification depends on the type of processor which has been provided. Most computers have their processors made by an American firm called Intel.

8086/8088

The first IBM compatible computers were called 8086 or 8088. They can be bought secondhand for almost nothing, although they might be both proficient and reliable for word processing. Their speed is 6 or 8 Mhz. They usually have hard discs which are very small by today's standards; but it is always possible to replace a hard disc at a price. The problem with the 8086 is not only its slowness but the fact that it is not practicable to give it more than its original 640 K of RAM. Machines of this type are not recommended. However, should you already possess such a machine, and are loath to spend money on a faster replacement, then it is still possible to function. The solution, albeit a compromise, is to add a maths co-processor. This is the manner in which the editor of *Model Engineers' Workshop* operates. Co-processors are described a little further on.

286

The next step up was the AT or 286 machine. These ran at 12 or 16 Mhz and could handle 1 Mb of RAM. It is possible to add extended memory to increase the RAM size to 2 or 4 Mb, but the process is both expensive and clumsy. The memory management of the AT machine is very primitive and overall frustrating.

386

In the so-called 386 machine, not only is speed improved, but memory handling is straightforward. This is the lowest specification for a computer which I believe is up to the job of handling CAD painlessly. But there are two types of 386 computer. The 386X is cheaper than a full 386 computer. The difference is rather erudite and doesn't appear to be of any relevance

to a normal user. (A full 386 uses 32-bit buses). The full 386 machine is sometimes distinguished by the appellation of 386P in distinction to the simpler 386X.

486

Then there are 486 machines. These have even faster processors, with speeds up to 33 Mhz.; and their performance is even better because they possess a built-in arithmetic co-processor. By all means purchase a 486 computer. Again there is a cheaper 486X variety against the full-blown 486P.

Portable computers

Attractive in concept, portables are only really suitable as a second computer. It is difficult to justify the purchase of a portable unless you really need to move around with a computer. My other computer is a 186. Portables do not yet possess the high screen quality which is essential for CAD unless a very expensive colour machine is purchased. Most portables which have a mono (non-colour) screen can work satisfactorily in colour, however, if you plug them into a standard VGA monitor. But then where is the portability?

Co-processors

A maths co-processor is a chip which can be bought at any time and plugged into a special socket inside the computer. The co-processor performs mathematical calculations involving decimals faster than the computer's original main processor. CAD programs in particular are performing thousands of calculations continuously, and the addition of a co-processor can enhance performance significantly. There is a separate co-processor to match each type of main processor. The 486 machines do not need a co-processor; they already have one as an integral part of their main processor. The slower machine, the more desirable is a co-processor.

The Mouse

This is a hand-held object connected to the computer by a cord, rather like a television controller. Some models are

connected by a beam rather than a cord. The object of the mouse is to enable swift and sensitive manipulation of the cursor on the screen. An explanation follows.

When we operate the keyboard, the screen shows a so-called cursor which indicates where whatever it is that we are typing will be displayed on the screen. This cursor advances automatically when we are keying in text during word-processing. For drawing purposes we can make the cursor move anywhere along the screen surface by pressing any of four arrow keys. But this is rather a clumsy procedure. It is much simpler to use the mouse. The mouse is rolled along the table top; wherever the mouse goes, the cursor faithfully follows.

A mouse is used constantly in the Macintosh world. Not everybody likes to use it for routine computing. But everybody concedes that it is very useful indeed for the purposes of CAD. We shall need one.

Colour Monitors

Colour is essential for CAD. The terminology surrounding monitors is confusing. Early colour monitors used a system called CGA. Then came EGA. Now we have VGA. Super VGA is also available. We should not buy a monitor whose standard is less than VGA. But I have seen so-called VGA monitors the quality of which was appalling. Should you be offered a choice between "standard" and "high resolution" VGA monitors then either take the latter or steer clear altogether. Reputable VGA monitors are always of high-resolution!

Screen size is measured diagonally. The commonest screen size is called 14 in. - but that seems to include some of the surrounding plastic border.

It is always wisest to be able to see the complete computer before purchasing. The monitor should be completely free of flicker, and a pleasure to look at.

Printers and Plotters

Printers

The choice of printer will depend on whether you need one for CAD only, or want to handle correspondence as well. If the latter, and unless you need to produce professional quality drawings, then the old-fashioned dot-matrix-printer (DMP) is the most versatile instrument. The DMP produces each letter or symbol by printing out a combination of tiny dots from an array of tiny pins. The more dots there are portraying each character, then the better the resolution. Cheaper printers use 8 pins; the quality of their output does not satisfy everybody. Should you already possess one, then use it! But if selecting a new machine then I believe that the small price differential between an 8 pin and the equivalent 24 pin DMP is worth paying. 24-pin DMPs are much cheaper than they used to be, and give a much improved resolution. A DMP printer is very reliable and it can produce copies, using carbon paper, just like the old fashioned typewriter!

If output quality is a high priority then an ink-jet printer may be considered. These printers draw by directing a continuous stream of ink onto the paper through a tiny nozzle. But an ink-jet printer cannot be used to make copies of correspondence because it is non-impact in action.



Two internal views of the Acorn A3010 home computer, this would require an upgraded memory, and possibly the addition of a hard disk before CAD would be a feasible proposition.

Both DMP and ink-jet printers can be bought in versions which will print out colour. There are potential difficulties with an ink-jet printer which is not properly maintained; it is a more sensitive system than the robust DMP, but it undoubtedly gives better print quality.

Laser printers are of similar quality to the ink-jet but considerably more expensive. Laser printers are the choice for offices needing to turn out large number of printed pages in a short time. Neither the DMP nor the ink-jet printer can compete with a laser printer on speed.

A further printer system providing excellent print quality is the so-called bubble-jet. This is a relatively new development, and it appears to be similarly priced to the ink-jet. Canon markets a word-processor (not a computer) having a built-in bubble-jet printer so I assume that the system is reliable and trouble free. Small bubble-jet printers are also available for use with portable computers.

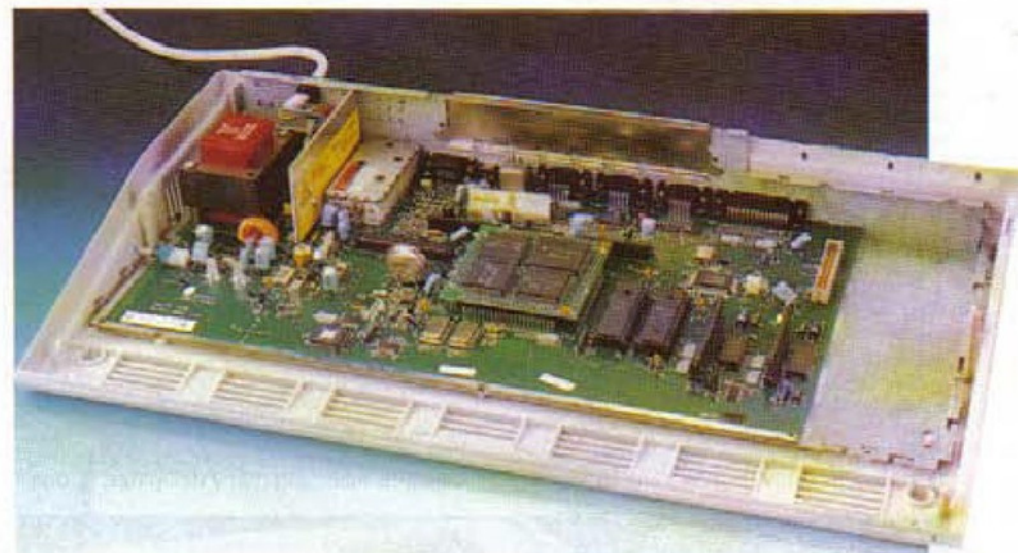
All printers will print graphic output far more slowly than they write normal text. Before actual printing can take place, the program has to put considerable effort into rearranging its stored version of the drawing so that it can be printed out line by line from the top of the paper.

Compatibility

Irrespective of which printer is purchased, it is important that it should be compatible with standard hardware. It is advantageous to know beforehand which CAD program you intend to use. Each program lists the printers and plotters which it supports; make sure that the machine which you buy is either on that list; or is guaranteed to be compatible with one of the machines on that list. Otherwise your drawings will never print out satisfactorily.

Plotters

In a plotter, the paper remains stationary (except in very large plotters) whilst a pen moves freely over the paper. There can be a battery of pens, one for each colour,



and/or line width. Plotters produce their output faster than do printers because they do not need to recalculate the drawing before commencing to plot. A plotter is the choice of professionals, particularly as larger sheets can be accommodated than is the case with printers.

Final Words

The bulk of the article has thus far been devoted to a rather dry description of relevant technical terms. Here are some general comments which it is hoped will be of interest.

Organising the hard disc

The hard disc is used to hold our CAD program, our Word Processing program if we have one, and any other program that we buy. The hard disc will also hold, at least temporarily, all the drawings which we prepare, letters which we type, and whatever else we produce using other programs. The hard disc is accordingly

storing many different things. Unless we know how to separate the hard disc into sub-directories then we shall never find anything. The hard disc will end up as if an office has been ransacked with all the files strewn higgledy piggledy across the floor.

We need to be able to control the storage of everything within the hard disc; this is essential, whatever the use to which we put our computer. I refer to this sort of activity as housekeeping. Without good housekeeping, any computer enterprise will very soon come to grief.

There are two separate ways in which housekeeping is effected. One is by applying a basic knowledge of about a dozen DOS commands. The other is to do exactly the same thing, but using the graphical facilities offered by Windows; see the section after next.

DOS activities

Whatever way our housekeeping is carried out, these are the sort of activities with which every computer user should be

familiar before seriously beginning to use CAD itself.

How to create a new directory or sub-directory. A directory is the equivalent of a filing cabinet; a sub-directory is a drawer within that cabinet. The hard disc may be divided into as many directories as we have major activities. How to copy from floppy discs into any selected sub-directory. How to copy from one sub-directory to another. How to delete unwanted files or sub-directories. How to list what is stored in any sub-directory. How to copy from a sub-directory onto a floppy disc; a vital procedure for backing up the existing system.

Windows

It is becoming the trend to include (bundle) Windows ready loaded within new computers. Take advice before retaining it! It could prove disadvantageous, especially if your eventual CAD program is not Windows based.

Windows is a graphical environment. It is supposed to make housekeeping easier. Instead of keying in commands at the keyboard, an icon is pointed to by use of the mouse; something then happens, depending on which icon has been selected. I believe that in the long run everybody's interest is best served by learning how to issue straightforward housekeeping commands in pure DOS.

In Windows favour is the fact that much attractive non-CAD software is available which works only if Windows is loaded. It is also possible to transfer information from one program running under Windows to another. And more than one program can be run simultaneously. Finally, there is a uniformity of command structure between different programs running under Windows which is totally absent otherwise.

There are also disadvantages! Firstly, Windows requires a lot of disc space to accommodate itself; and the Windows versions of programs are considerably more space hungry than their DOS equivalents. Secondly, programs operating under Windows perform markedly slower than their simpler DOS equivalents. This slowness can only be overcome by using

the fastest computers available equipped with oodles of megabytes in their RAM. I am sceptical about Windows, notwithstanding the dazzling appearance of certain programs written especially for it, unless there is a genuine need to use a specific Windows-based application. And this is not the case with the currently available CAD programs of interest to readers of this magazine.

Utility programs

A utility program is a program intended to help us with our disc housekeeping. Take the famous Norton Utilities for example. Sold largely on its ability to retrieve files which we might accidentally have deleted, Norton Utilities possesses other facilities which it would be difficult to match using either DOS or Windows. I regularly use the Norton Utilities to: find out where I've stored some file when I can't remember where I put it; to sort all the files in a directory, or in all the directories; and to display a brilliant graphical map of the layout of my hard disc. And there are other useful features within this utility which it is not appropriate to detail here.

Backing up

The need for backing up cannot be over-emphasised. Of all my utilities the one I most prize is Fastback Plus. This allows me to plan backing up strategies for each and every purpose; and then Fastback backs up for me with incredible efficiency. If it is necessary to restore backed-up discs, Fastback restores everything exactly where they used to be, even recreating the original sub-directories should these have been erased.

Training

Some people learn readily from the manuals supplied with the hardware and software. But it can be a little daunting to be faced with thick manuals containing perhaps hundreds of pages. Much time can be saved by attending a reputable training course.

Courses vary from highly organised sessions including many delegates, to one-

to-one classes the agenda of which can be matched to the attendee's individual interests. Expect to be charged £250 - £350 per day by the larger companies; a one-man business working from home will charge half that. It is also possible that the local College of Further Education is running relevant Evening Classes.

Learning CAD

My advice in tackling any new package is two-fold. Firstly, do not attempt to learn everything in the manual. Good software is so powerful that the programs we purchase usually contain far more than we need. The secret is to learn as little as possible, as long as that little allows us to do what we need to do! I feel that the best way to learn any new program is to have a concrete application in mind. This way, we read everything enthusiastically to see whether it is, or is not, relevant to our personal problem. Good Luck!

Prices, and sources of information

This article is being written in early March, 1993. It would not be helpful to quote current prices. An excellent source of further information is the monthly *PC Magazine*. The reviews therein are of an awesomely high standard and very thorough. But a beginner may not feel at ease with the assumed level of experience; it is highly desirable, accordingly, that a suitably experienced person be available for help and advice.

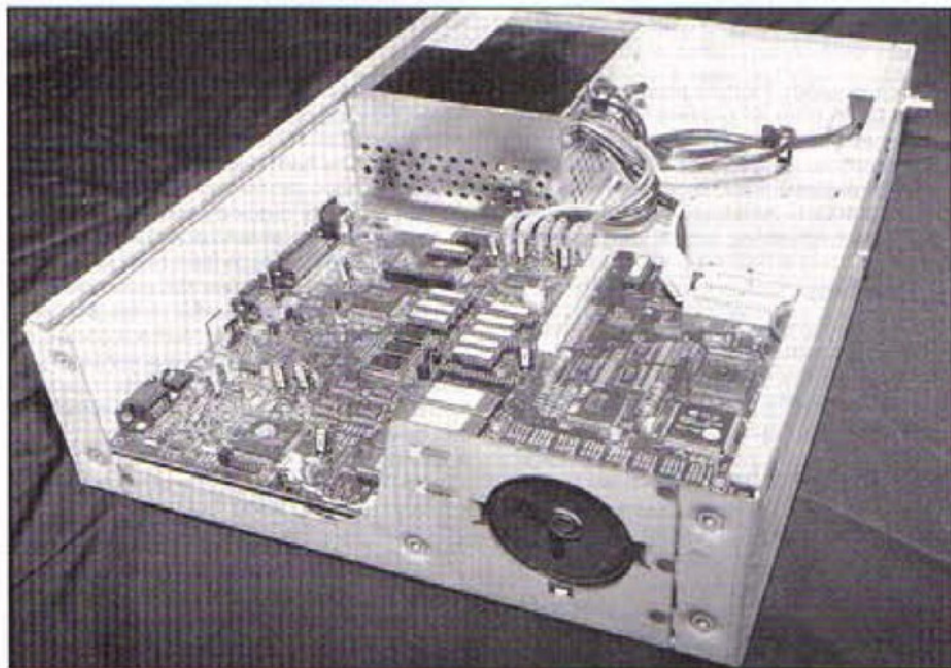


Postscript by the Editor

In this article Michael has, quite rightly, set a high standard for the computer to be used with CAD. If you intend to purchase a new machine you will have little choice but to go down this route, as the less able machines are no longer generally available. However, if you already have one of the earlier machines, or can only afford to purchase a secondhand one of that calibre, all is not lost. The accompanying article in this issue regarding CAD chooses three software packages that will function reasonably well on these machines.

The need to purchase the correct machine for the job is thought very important, and the following paragraph, a quote from a subsequent letter from Michael, highlights this fact very clearly. If therefore you intend to purchase a complex CAD package, especially if 3D, or produce very involved drawings, do take his recommendations very seriously.

"Since becoming immersed in my DesignCAD 3D I've come to realise that there can be a distinct difference between computer requirements between different CAD users! It all depends on whether the user has a 2D package (such as yourself), or a 3D one (like me). In the second case the computer is asked to undertake tasks far greater than any required in the first. Overall, my drawings operate at a reasonable speed, including redraw. But where a fairly complex hidden-line removal is concerned, then there can be a formidable wait. Were I not to have a 386, with no co-processor, then I imagine it would be necessary to leave the machine on all night. This should be pointed out in my article."



The circuit board fitted to an A5000 computer, Acorn's top of the range model.



1: A model 1930s North sea trawler made to a scale of 1/4in. to the foot.

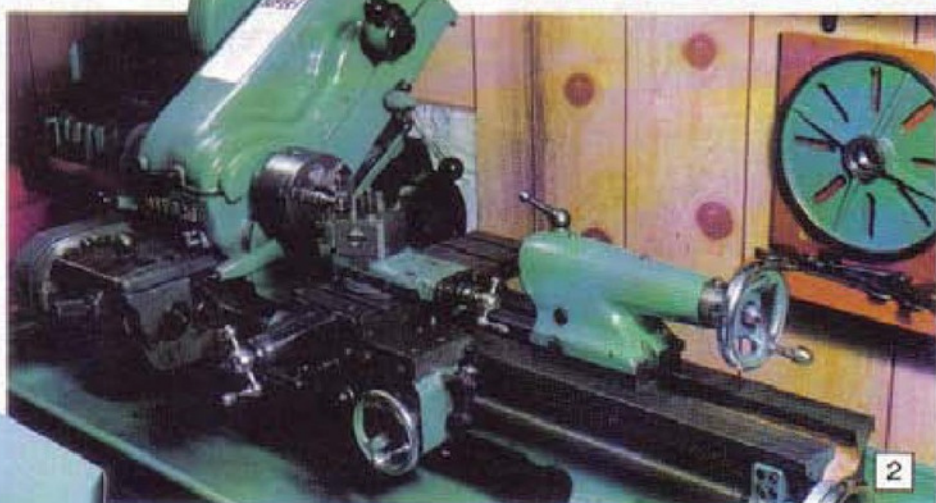
Gordon Barber has, for many years, had an interest in woodwork, showing itself in a wide variety of projects, not least the model boats seen in this article. However, some six years ago, he decided to move into metal working and equipped his workshop accordingly. Read this article and see how well he has done, even though he has had no formal engineering training, having spent his working life in accountancy.

We visit - GORDON BARBER

When Gordon left school and started work, he quite rapidly found himself being moved into the financial office. Since that time his working life has been in accountancy. He is therefore, yet another subject of one of our reader visits who has not had formal machine shop training.

A Grayson lathe

Gordon purchased his first lathe, a Grayson, in 1955, even so, he did not become seriously involved in metal working until 1987; when he commenced to set up a



2: Gordon's Myford Super Seven lathe, note the extra large faceplate just visible on the right of the picture.

3: A Sealey Mill/Drill finished in their brilliant red colour.

4: Economizing in terms of clamping methods available for the milling machine is not a wise move. This type of clamping set is well worth considering.

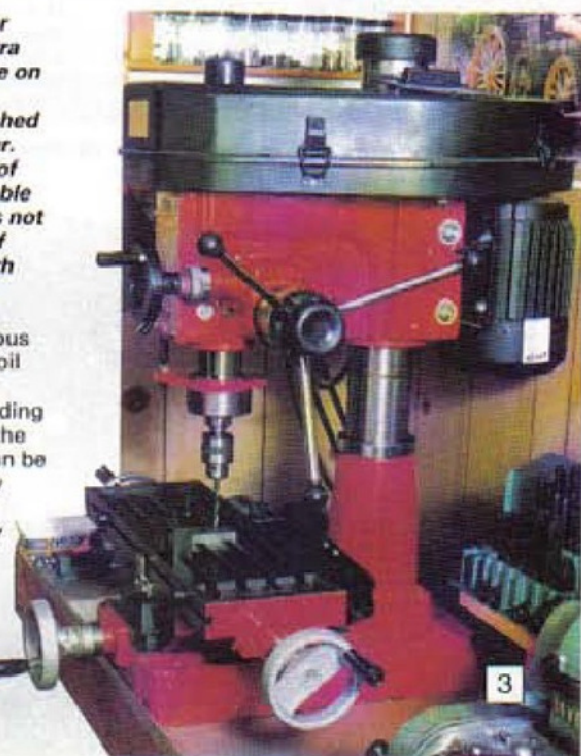


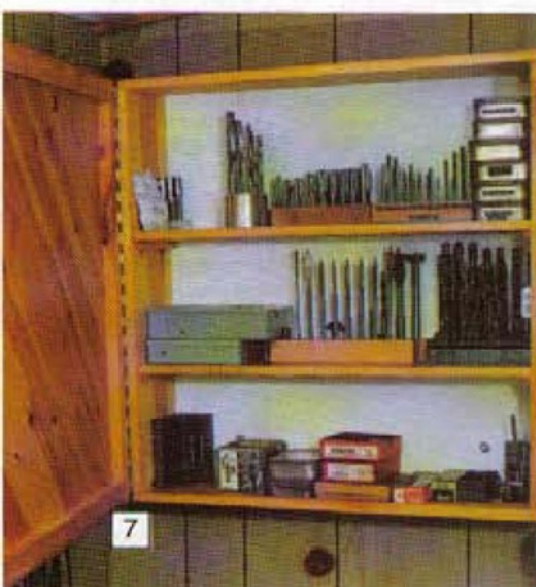
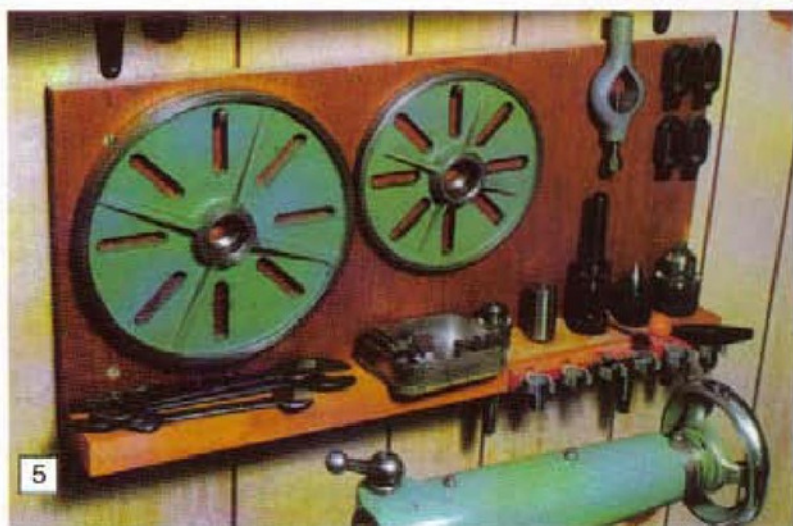
more fully equipped workshop. From that early start he mainly occupied himself with woodworking activities, with this taking the form of model boat building from around 1985. An example of Gordon's fine work in this direction can be seen in **photo 1**, this being of a 1930s North sea trawler.

The moves toward a better equipped workshop in 1987 included the provision of a new workshop building. This 12ft. x 7.5 ft. workshop is of wood construction and has a solid concrete floor. The walls are insulated using polystyrene, and then lined internally using plywood having a simulated knotty pine wood planking appearance. This gives a pleasing

appearance, as can be seen in the various photographs. Heating is by an electric oil filled radiator.

On completion of the workshop building a new lathe was purchased to replace the Grayson and this, a Myford Super 7, can be seen in **photo 2**. The lathe was quickly followed by a Sealey Mill/Drill, **photo 3**; a clamping kit, **photo 4** has recently been purchased to complement this machine. I feel many of us will endeavour to make do with home made items for this purpose; this may be perfectly acceptable, providing the home made tooling is of adequate strength and variety.





5: Storage for the main lathe accessories.

6: Storage for small tools using a proprietary system.

7: One of Gordon's rather nice wooden cupboards. Note the cross boarded doors.

However, Gordon considers the purchase of this kit of parts a very worthwhile buy.

A tidy workshop

Gordon keeps a very tidy workshop, as evident from **photographs 5, 6 and 7**. **Photograph 5** shows the arrangement behind the lathe where the lathe accessories are readily to hand. Of interest is the provision of a larger than normal faceplate. Most readers will, I am sure, have

found when mounting items on the standard face plates provided, that they are a little short of space. Having a larger plate available could help considerably in these situations.

Another storage area is that seen in **photo 6**, another similar board being available elsewhere in the workshop. This is a proprietary system; Gordon is unsure as to whether this can still be purchased. Does any reader know if this is still available, and if so, from where?

Photograph 7 shows one of his storage cupboards, I feel this, with its cross panelled doors, gives an indication of Gordon's interest in woodwork. Unfortunately no other photograph shows these in their closed position, I really must take some more general workshop pictures on future visits.

Seen on the top shelf is a storage base

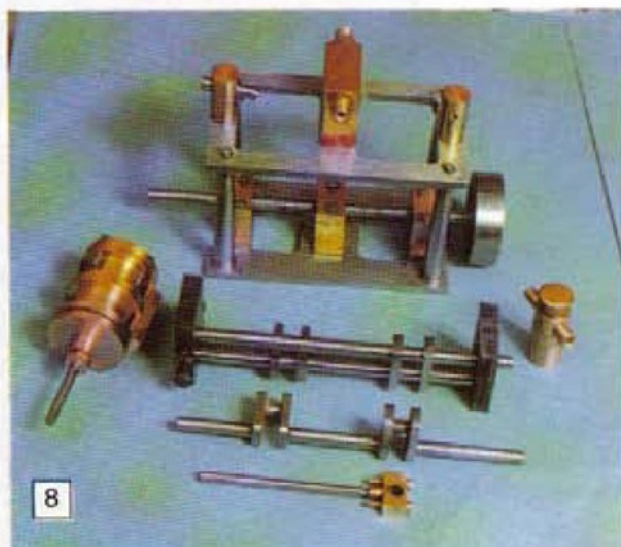
for reamers, this inspired by the simple drill stand article in issue 13 of *M.E.W.* The picture also shows his latest boat project, this one of a Thames coastal sailing barge made to a scale of 1/16". This is called *Celia Jane*, and is to a design by David Metcalf which was published in *Model Boats* magazine in 1984. It is now available from Argus Plans department and is number MM1365.

A twin cylinder oscillating engine

Gordon is still involved in model boat building; he has been treasurer of the local model boat club for the past four years. He now considers his main interest lays in metal working. One method of combining the two interests is to make the engine to power the boats. An example of this is seen in **photo 8** showing some parts for

8: Some of the parts from the twin cylinder oscillating steam engine in the course of construction.

9: A Keats angle plate and a fixed steady. The Keats made from a College Engineering Supply casting, and the fixed steady from one supplied by Blackgates.

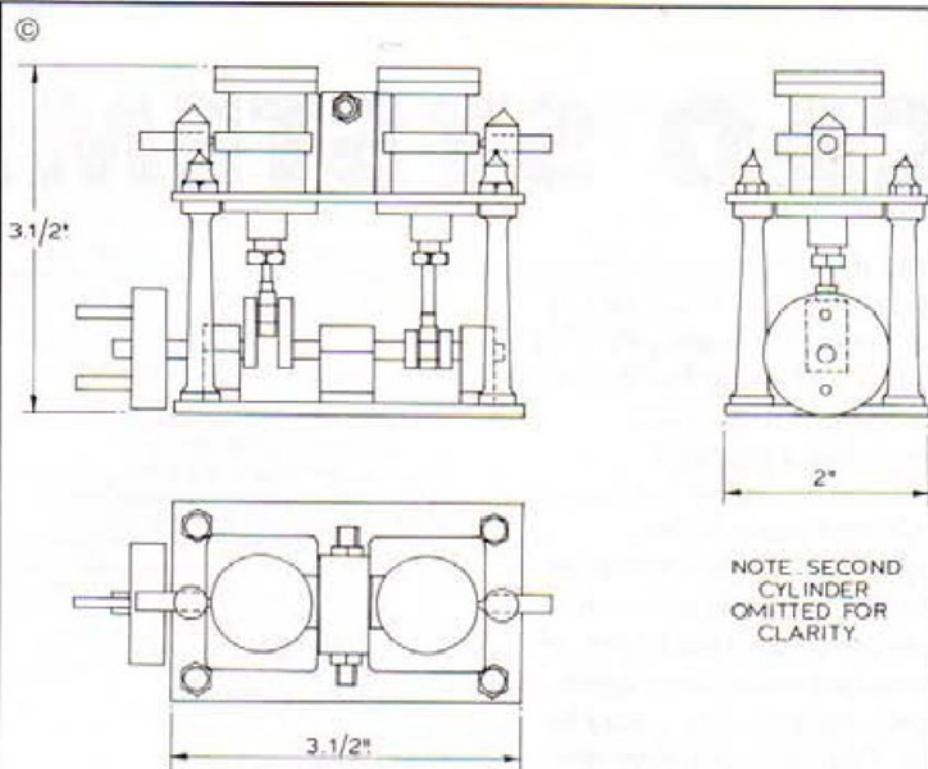


an engine taken from *Model Boats* magazines of July, August and September 1983. This is an Argus publication and photocopies of the article can be obtained via the Photostat service. Plans of the engine are also available from Plans service, the number is MM1349, we show the assembly drawing for the engine with this article. This is a twin cylinder oscillating steam engine. The photograph shows one completed crankshaft, a second mounted in its Assembly Jig awaiting brazing. A Stuart Models Beam engine is also under construction.

To increase his knowledge of workshop practices and to benefit from the wider range of facilities available, Gordon has for three years attended the local college. However this facility has been withdrawn, but through it, some of those attending have formed a small model engineering group.

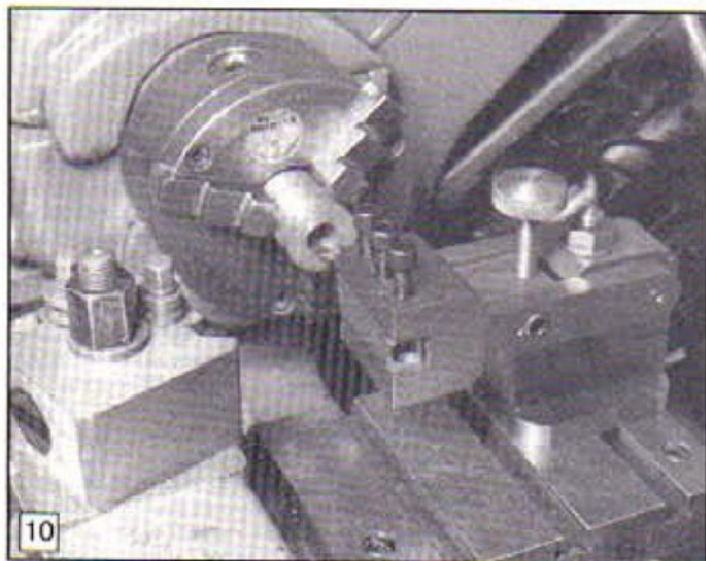
In order to increase the facilities available in the workshop, and to provide some interesting metal working experience, he has made a number of items of workshop equipment.

Photograph 9 shows two, a Keats angle plate, featured in the Winter 90/91 issue of *M.E.W.*, and a fixed steady. The Keats from a casting supplied by College Engineering Supply* and the Steady from castings supplied by Blackgates Engineering**. To achieve a good presentation he has acquired some matching Myford paint and all the bright parts have been blackened.



General arrangement twin oscillating launch engine

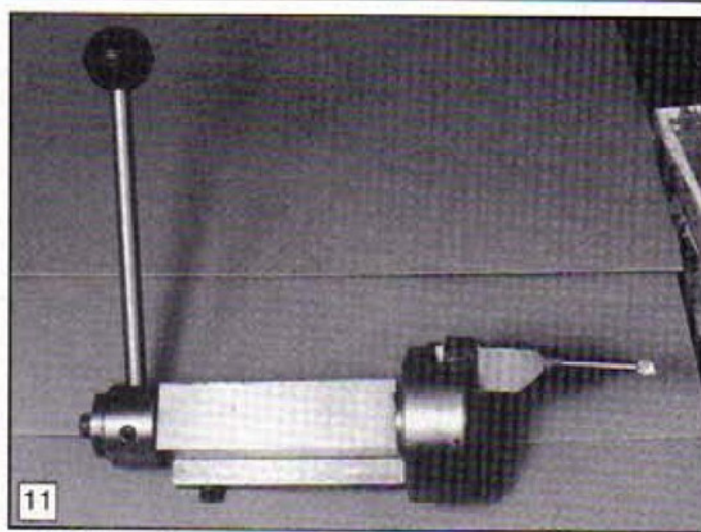
An extract from plan MM1349. The engine currently under construction by Gordon. A full drawing of the parts of the engine is available from Plans Service, Argus House, Boundary Way, Hemel Hempstead, HP2 7ST.



10: A swing clear tool post being used for boring. The tool can be swung clear for easy measurement of the bore being made.



12: A bench grinder, fitted with improved rests made by Gordon.



11: A ball turning attachment.

Another use for the swing clear tool holder

In the visit to Geoff Walker's workshop we featured a swing clear lathe tool holder, stating that it was used for screw cutting, permitting the tool to be lifted clear enabling the saddle to be wound back without losing the position of the tool. Following this a reader wrote stating that it is equally useful when boring in the lathe, enabling the bore to be measured without having to wind the saddle a long way back. Gordon uses the device for this purpose and this can be seen in **photo 10**.

Photograph 11 shows a ball turning attachment, whilst **photo 12** shows some simple but rather nice tool rests he has added to his Black and Decker grinder. Most grinders of this type, whilst having reasonably robust rests, are limited by their lack of adjustment. This simple design goes

some way to overcome the limitation.

We thank Gordon for making it possible for us to visit his workshop and to see the varied work which he undertakes.

Copies of articles previously published and mentioned above can be obtained from: Photostat Service, Argus Specialist Publications, Boundary Way, Hemel Hempstead, Herts HP2 7ST. For details of the plans mentioned send to Plans Service at the same address, why not purchase a Plans Handbook?

*College Engineering Supply is at, 2 Sandy Lane, Codsall, Wolverhampton, WV8 1EJ. Tel/Fax 0902 842284.
**Blackgates Engineering is at, 209 Wakefield Road, Drighlington, Bradford, West Yorkshire, BD11 1EB Tel 0532 853652.

CAD SYSTEMS

PART 2

With the continuing increase in the numbers of computers in the home, the possibility of its use as a drawing facility for the home workshop is fast becoming a practical proposition. In the last issue we reviewed some of the capabilities of the system, in this final part we review a number of CAD packages, of those looked at, three have been chosen as very easy to use. Coincidentally they are among the cheapest available.

In this, the second article on the use of Computer Aided Drafting (CAD) in the home workshop, it is primarily intended to review a number of software packages. From these, we select those that will most usefully benefit the reader who wishes to make use of a capable package, but can only justify spending a limited time in mastering its facilities. If you consider that you are likely to make considerable use of a system and/or become an enthusiast, do read on, but it will be necessary to look further afield for expert guidance.

However, even the packages recommended in this article are capable of producing drawings almost as complex as can be expected from the more involved

packages. The drawings published with this article, and made on the recommended packages, are proof of this point. They are produced using differing methods of printing, so that the differences in quality are in no way intended to represent differences in the drawing packages.

The advantage of the packages which are more involved than those recommended later in the article, is likely to be the ease, and therefore speed, with which very complex drawings are produced. It must be added, that I did not conquer them sufficiently to be sure of this. Even so, it is unlikely that the eventual saving in time will ever justify the additional learning time, other than for those who will make considerable use of their drawing package.

The review machine

The review has been carried out on the equivalent of an IBM XT machine (8086/8088) fitted with math coprocessor. For any reader purchasing a new computer, and with sufficient cash available, this would not by present day standards, be considered adequate. For more detail, read the article elsewhere in this issue, on choosing and setting up a computer system. If you are contemplating making a purchase, buy the most capable machine you can afford. Even so, with a faster and more capable machine, the three packages recommended would still be the recommended ones, if initial ease of use is an important consideration.

It is probable that few readers will contemplate purchasing a computer solely for CAD, and it will be those who already

own a computer for other purposes who will be prepared to spend an additional £50.00 to £150.00 for CAD software. On this basis, many of the machines owned are likely to be comparable to the test machine, but probably without the math coprocessor.

Fit a math coprocessor

It must be said, that without a math coprocessor the system will be very slow, particularly when changing the screen view of drawings. Because of this, it is recommended that a math coprocessor is fitted to the machine (probable cost around £50.00 to £150.00). It can be retrofitted after the CAD package has been tried out; as should your requirement be for only occasional use, you may find that you are prepared to accept its slow operation. One system, recommended later, is less affected by the absence of the coprocessor, more about that later in the article.

2D Drafting

The article deals only with 2D drawing packages; these are adequate for the type of drawing found in M.E.W. If you eventually choose to set up a 3D system, a 386 machine with math coprocessor will be an absolute minimum. We hope to have two brief articles on 3D systems shortly.

Some software packages reviewed

A number of CAD software packages have been reviewed, all being at the lower end of the price range, £50.00 to £150.00. Reviewing software packages is a very time consuming operation, and CAD is no exception. Therefore detailed reviews had to be limited to those which quite early in initial testing began to look promising from the ease of use point of view. This seemed justifiable as the idea is to recommend packages which are adequate for the home workshop use and, most important, quick to learn.

In the event, I wound up with three packages which met these criteria, others will get a mention at the end of the article. All three systems had their plus and minus points, it is fair to say that with the use envisaged for them, all three should be adequate.

The packages chosen are:- DraftChoice V2a, AutoSketch V3.0 and EasyCad2 V5.0b. These range, in order of cost from around £50.00 for DraftChoice to £120.00 for EasyCad2. DraftChoice is a very capable package at a rock bottom price. AutoSketch has a maturity to it with many tasks frequently being just that little bit easier to perform than the other two. EasyCad2 has a far wider range of facilities and is as a result, more suited to the enthusiast whilst still being very easy to use for the less demanding user, it is also extremely fast.

Outstanding features

1) DraftChoice. This package really has no outstanding features other than being very good value. If cost is a consideration then I have no doubt that the majority of



A typical home CAD workstation, the one used for the review.

users will find this quite adequate.

2) AutoSketch The package really does have one outstanding feature; its text facilities, these are far superior than those provided on all others reviewed. I believe far better than on much more expensive programs.

3) EasyCad2. This system's outstanding qualities are its speed, which results in a very rapid drawing of the image on the screen, also its ability to be systemized to the requirements of the individual user. Apparently the speed of this system is faster than almost all other packages, irrespective of cost. Its adaptability makes it more complex for those wishing to make use of these provisions; it can be used without these facilities. In which case its ease of use is comparable to the other two.

Features compared

To go into a detailed comparison between the systems for all the major features would make this an unacceptably long article. In any case, the differences are frequently only one of method, in terms of ease of operation the differences are minimal. Because of this, only a few of the more important aspects are discussed. It may be necessary to go back to the original article to recap on the purpose of the features being discussed.

Scaling

The newcomer to CAD, attempting to make use of the recommended packages for the first time, will find at least 90% of the essential features almost instantly usable, once the basic operating procedures have been mastered. This will even be without using the manual in most cases. One area where this is unlikely to be the case, will be that of scaling the image being drawn on the screen, to the size of the item being drawn, and then to its final printout.

When first switching on there will be, apart from the various menus around the edges, a blank screen where the drawing is to be created. The question is how large is the screen in terms of the dimensions for the part to be drawn, also the final print out size.

All three systems require a little effort to understand the requirement, but of the three, DraftChoice is the easiest. On being instructed to start a new drawing it will give the option of four drawing sizes, selection of one will automatically create a rectangle on the screen that represents this size. A fifth option will allow the user to detail other values so it is not restricted to the four sizes.

Repeat operations

Very often it will be found that an operation, when selected, will require to be used repeatedly. Typically when selecting to draw a line it is probable that having drawn the first line, more lines will require to be drawn. If it were necessary to return to the drop down menu, or type in a command at the keyboard, each time to repeat a command (some systems do) it would become a chore. All three packages were good in this direction, with AutoSketch the best as it immediately made the command available. The other two required two additional pushes on the mouse button, but as the mouse is kept to hand this is quite acceptable.

Changing settings mid operation

When carrying out an operation it can frequently be found beneficial to make changes to some other aspect of the situation mid way through the process. Typically when drawing to a snap value of say $\frac{1}{16}$ in. and having established the first end of a line, then deciding that the other end should fall on a $\frac{1}{8}$ in. increment, to do this it would be necessary to change the snap value.

Another possibly is to commence a line, then to require the other end to be located at a part of the drawing which is off screen. The reader may consider that to overcome this, it would be necessary to bring more of the drawing onto the screen by reducing its scale. However, if this then makes it too small to locate the ends of the line, it would not achieve the required result. To complete the line easily it would be necessary to change the view, after locating the first end of the line, either by the use of the zoom or pan commands. These are but two instances where this type of situation will arise.

Only AutoSketch fully met this important requirement, EasyCad2 could change the snap value but not the view whilst DraftChoice could only turn snap on and off. Of course there are ways of overcoming these shortcomings but they do add additional keystrokes which will complicate and slow down the completion of a drawing. This is particularly a problem when unable to change the view.

Text

When adding text to a drawing this will vary from the need to add a simple one line note, to the inclusion of instructions which could run to a number of paragraphs. Another requirement could be the inclusion of schedules for such items as hole sizes, or perhaps a parts list.

All three systems would cope quite adequately with the one line note, but beyond that AutoSketch was far ahead of the others, having a simple text editor with such facilities as word wrap, insert and cut and paste being available. The other two treated each line of text as a separate entity, though DraftChoice was slightly the better as it did re-display each line in turn when editing a multi-line note. When using EasyCad2, each line would have to be recalled separately. AutoSketch also had a better range of text styles, (fonts) one of which had a constant spacing irrespective of character, this makes it ideal for producing schedules.

Undo and Redo

The undo feature should, as well as dealing with single entities, perhaps a line or circle, be able to reinstate changes made to large areas of a drawing. This would be particularly important for a mass erase, for which there would be no other way back than to redraw it all again. All three would deal with the last operation, which is the most crucial requirement, whether it be a simple operation or a mass edit.

AutoSketch and DraftChoice could also step back through all operations since the drawing was last saved to disc. Additionally on AutoSketch is a complementary command called Redo, this reinstates changes undone with the undo command. This permits all stages since the last save, to be gone through, forward and backward, at will. As EasyCad2 functioned on the last

change only, repeated use of the undo command in effect gave undo and redo of the last change only.

Some of the systems tested other than those recommended, even the more complex ones, were particularly poor in this respect.

Alternative methods

CAD systems can provide alternative methods of producing the same basic image, making it easier to produce the required result in some cases. An example of this is that of drawing a circle. The most common method of creating a circle is as shown in **Sk.1** in the last issue, here the centre and a point on the circle circumference were marked. Consider now a requirement to draw a circle between, and touching, two parallel lines. To mark a point on each of the lines to indicate the diameter would be an easier approach, particularly so if the two lines were some random distance apart resulting in the centre of the circle being difficult to establish.

EasyCad2 has a wide range of alternative methods of providing an image whilst DraftChoice has a few, AutoSketch provides no such alternatives.

Picking a group

For many operations such as erase, move and mirror, it is necessary to choose the area of the drawing on which the command is to be effective. The obvious method of doing this would be to draw a box around the area, unfortunately this approach is frequently inadequate as the part of the drawing invariably does not fit nicely into a rectangular area.

In the case of AutoSketch a novel method is adopted which goes some way to overcome the problem, but unfortunately is sometimes inadequate. If the box is started to the left of the area and made to the right, it will appear with solid lines and will select only those items which are totally inside the drawn box. Alternatively, if started on the right and drawn to the left, the box will appear dotted and will select all items, even those that are only part inside the box. Where this is inadequate then each part must be selected individually until all items to be moved etc have been selected. This can be a time consuming process.

For the other two, it is possible to select the bulk by using a box, then to amend this by adding or subtracting entities to those already selected. EasyCad2 gives the most flexibility in this respect.

Adaptability

All three packages permit small programs to be established so that repetitive actions can be called up and be repeated automatically. DraftChoice was limited to 6 such programs, but when made they were easy to use being called up by pressing a single key. AutoSketch had no limit to the number but once made they were a little more difficult to initiate.

EasyCad2 was by far the most able when it came to customizing the package, even to point of being able to establish new drop down menus, or adding to, or modifying, existing menus. Line patterns and fill patterns can easily be changed and new ones created. The adaptability of EasyCad2 does make it more complex and hence a little more difficult to fully master. It is not essential to the operation of the system,

and without it EasyCad2 is only slightly more complex to master than the other two.

Manuals

All three recommended packages are supplied with manuals, not surprisingly DraftChoice, the shareware package, has the simplest. Whilst its simplicity leaves some things a little vague, for the majority of commands it makes easy reading. The other two have very detailed manuals as one would expect of packages aimed at the industrial user. These, compared to many manuals, are easy to follow.

Both DraftChoice and EasyCad2 have on screen help available, which is handy, making it unnecessary to reach for the manual, in most cases, when help is needed. It may come as a surprise to learn that AutoSketch has no on screen help, but in view of its ease of use, this is a feature which is not much missed.

Final comment on the three systems

If you still feel unsure as to which package to acquire, it should be understood that for the probable drawing requirement, all three packages can perform adequately, so choice will have to be made considering other factors. If you are a computer enthusiast then the ability to customize EasyCad2 will make it the program for you, whilst if cost is all important then it will have to be DraftChoice. If you want the minimum learning time, or consider text to be an all important feature, then it should be AutoSketch. Do remember that drawings done using CAD will lack individual style - one reason why some professional draughtspeople tend to dislike the method.

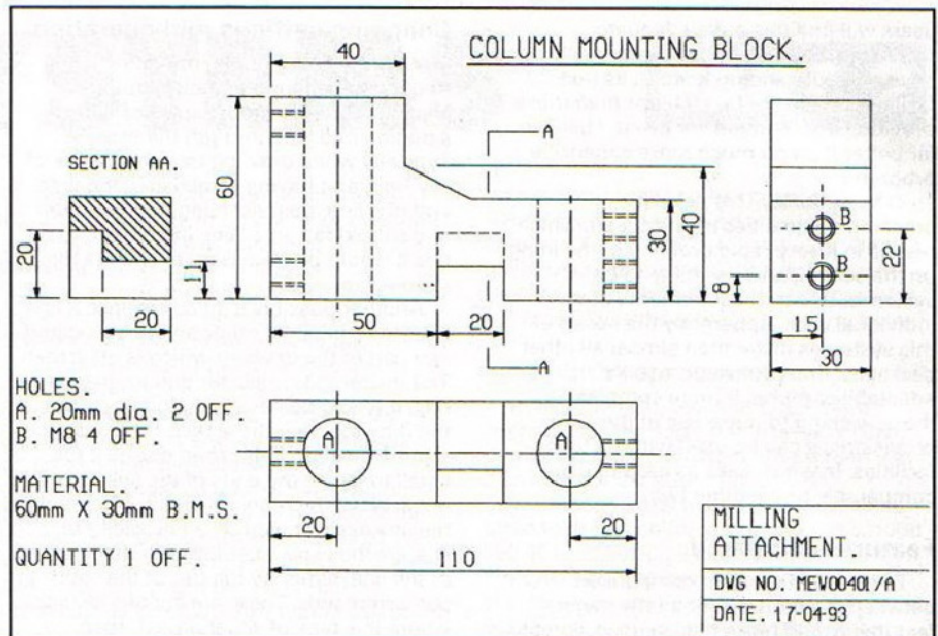
Three Dimensional drawing

For the reader who wants the ultimate system, a 3D package may be worth considering. These will of course be far more complex to use and therefore take a considerable time to master. 3D packages are generally very expensive but both the suppliers of EasyCad2 and DesignCad (mentioned later) have such packages which are at the bottom end of the price range, £200.00 to £300.00.

System requirements

Without doubt, software is amongst the fastest changing area of modern life. This, coupled with the time taken to complete the review, and the two monthly publication on *M.E.W.*, makes it impossible to be certain that the review will be up to date at the time of publication. For this reason, the purchaser should make absolutely sure that the software purchased will be compatible with the hardware, should this already be available or being purchased separately.

As an example, the review copy of AutoSketch requires a computer fitted with a hard disc, whilst the earlier issue was capable of being used from a floppy only, perhaps the next issue may require more memory. However it is unlikely that the operation of the three recommended packages will change significantly so as to affect their ease of use rating. Where a system is capable of being run from a floppy it will be slightly more complex, as it will require discs to be changed as the



drawing progresses. It will also slow down the operation of completing a drawing.

The following notes regarding each systems hardware requirement have been taken from the suppliers data. The drawings published are an indication of what can be achieved, but those created on AutoSketch and DraftChoice are in no way an indication of the limit of what can be produced. The quality of the printout is as much a function of the type of printer as it is of the CAD software. As they have been printed out on differing systems they are in no way an indication of the quality of the CAD package in this respect.

DraftChoice

Version 2.0

Computer. IBM or compatible PC (8086 or better)

Memory. The system requires 380K to operate which on a 650K machine would allow, after loading DOS etc, about 200K for the drawing being produced.

Drawing complexity. **Sketch 1**, produced

on this system has 166 elements (lines, circles, etc). 200K would permit some 6000 elements.

Speed. **Sketch 1** takes 6 seconds to generate itself on the screen. The drawing was printed on a 9 pin dot matrix printer, (Epson LX-400).

Hard disc. Not essential, but preferable. Can be run from floppy discs, even 360K types.

AutoSketch

Version 3.0

Computer. IBM or compatible PC (8086 or better)

Memory. The system requires a total of 512K minimum, for running program and storage of drawing being produced, after loading DOS on a 650K machine.

Drawing complexity. **Sketch 2**, produced on this system uses 8% of available memory on a machine having 540K available after loading DOS etc. The drawing was printed on a Postscript laser printer.

Speed. **Sketch 2** takes 7 seconds to generate itself on the screen

Hard Disc. Essential, will not run from a floppy.

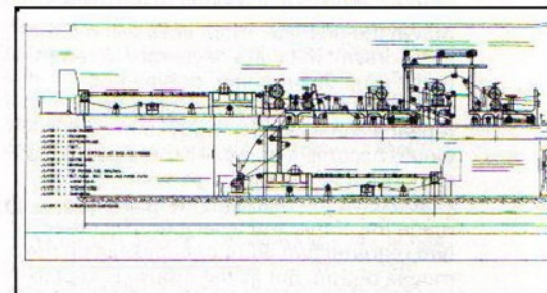
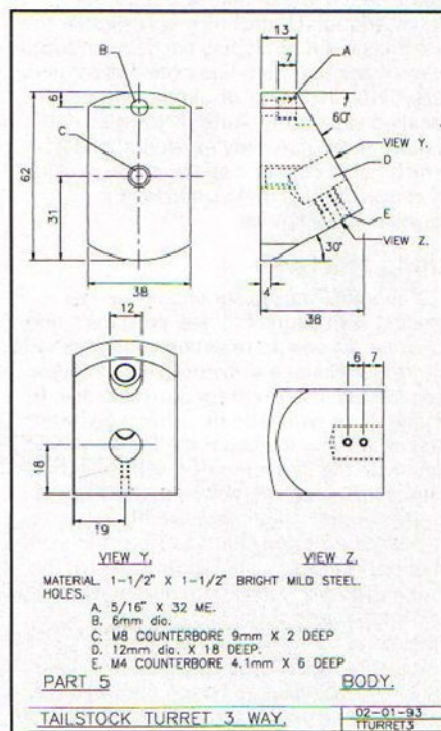
EasyCad2

Version 2.72

Computer. IBM or compatible PC (8086 or better)

Memory. At least a 512K machine, may need 650K machine depending on amount of memory taken up by loading DOS etc, check with supplier.

Drawing complexity. **Sketch 3**, produced on this system is an example of a very complex drawing, in fact too complex to display on an A4 sheet. As an indication of the amount of detail in this drawing the area in the box is repeated larger in **Sketch 4**. The complete drawing contains





The display of measuring and allied items.

We visit CHRONOS LTD



The display of cutting tools and other items.

Readers of *Model Engineer* over the last 10 years or so, and more recently, readers of *Model Engineers' Workshop*, also visitors to the Model Engineer Exhibition, will need no introduction to the name of Chronos. Commencing business in 1982, the company originally started with the main aim of marketing products of Chronos Designs, typically their Wheel Engine. This placing them firmly in the watch and clock makers and repairers field. However, in 1984 they branched out into supplying model engineers' requirements, since which time they have never looked back.

The company was started by Ray Smith, who together with his son Mark are still the owners of the company. Both Ray and Mark will be very well known, if only by sight, to visitors of the various national model exhibitions held, typically in London and at Stoneleigh.

Retaining the name of Chronos, with its link to clock making, perhaps confuses the situation regarding its ability to provide for the home workshop owner. But on reading

The name of Chronos will need no introduction to the majority of readers of *Model Engineers' Workshop*. We visited them to see what they have to offer, read on to find out.



A bulk buy of Zeiss micrometers in a number of sizes enables them to be supplied at very advantageous prices.

their catalogue, it will soon become obvious that, whilst still retaining some products for the clock maker, they are able to provide a wide range of machines, tools and materials to meet the needs of a wide range of home workshop activities.

A recent major addition to the range is the supply of raw materials, including mild steel, stainless steel, aluminium, brass, copper and phosphor bronze. These are only available in 12in. lengths for mail order, though longer lengths can be made available to callers, in this case it would help to phone the order in advance. Chronos also supply a range of free cutting silver steel (KEA108) in sizes $\frac{1}{8}$ in. to $\frac{1}{4}$ in. and 3mm to 20mm. There are frequent additions to the range, and a new catalogue, No. 27, has recently been issued. This can be had, price £1.00, send coins or stamps to this value to the address given below. New catalogues are issued at around 6 month intervals.



A good range of rotary tables, angle plates, milling chucks etc.

PAINT STORAGE

After using a little paint from a new pot always fit the lid back on as tightly as you can and store the pot upside down. The paint will form a seal around the rim and when next used the paint will not have formed that annoying skin on the surface.

Anton Vella

The catalogue contains the whole range of items sold, except perhaps for the occasional item in the showroom for callers only. Mail order accounts for around 95% of their business, though the full range, except for the larger machines, is on display at their premises and callers are always welcome.

Orders can be placed by phone, and for the benefit of callers who wish to save on phone costs by phoning at off peak times, or from other parts of the world due to the time difference, an answer machine is available, as is a fax machine. Chronos also take the major credit cards. All prices quoted in the catalogue include postage and VAT.



A range of vices.

and there is no minimum order charge. Ray and Mark frequently visit international trade fairs, such as at Hanover, and this enables them to make purchases direct from overseas suppliers which, in turn, helps them to keep their prices down. It also enables them to determine the quality, rather than placing orders blind, thus

helping to ensure a high quality to the items stocked. Even so, if any purchaser is unhappy with any item supplied, a full refund will be made on its return.

Whilst a computer is available to produce much of the paperwork, assisting greatly with the same day delivery aim, Ray even writes some of his own computer programs, both Ray and Mark pride themselves in the personal service given.

Except for the larger machines, an attempt is made to hold all items in stock and this is achieved to a very large degree. As a result of this, orders received before 4pm are dispatched the same day. Even so, if you do intend to travel some distance to make a personal collection, it would be preferable to phone to confirm that the item required is available.

If you wish to make a visit, the catalogue includes a map to make finding the shop easy. Opening times are Monday to Friday 9am to 1pm, and 2pm to 5pm, Saturday 9am to 12 noon. They are closed at the time of major exhibitions so, if in doubt, phone before travelling. A small car park is available. St. Albans is a nice city and Chronos is very close to the city centre, so why not bring the family and leave them in the city whilst you make your purchases.

To obtain a catalogue, or to ask for further assistance, contact Chronos Ltd., 95 Victoria Street, St. Albans, Herts. AL1 3TJ. Tel: 0727 832793, fax 0727 848130.



Chronos are agents for the Hobbymat range of machines, also Emco and Record.



Two of the smaller machines on offer. A variable speed grinder with a top speed of 6000 rpm, and a Proxxon 3 speed drill with a top speed of 7500 rpm.



Ray at the computer, used to speed up paperwork and ensure a same day despatch for almost all consignments. Ray is quick to point out that the use of a computer does not in any way minimise the personal service given by Chronos.

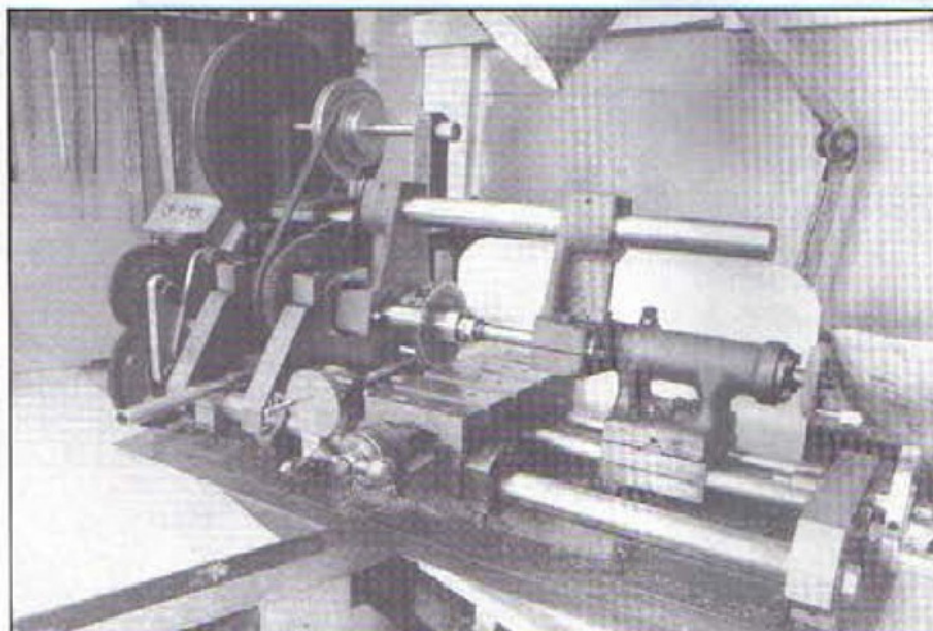
A LATHE MILLING ATTACHMENT

**FREE
PULL OUT
PLAN**

Very few home workshops have a horizontal milling machine, and yet this operation has distinct advantages over vertical milling for some operations. Running an arbor fitted with a milling cutter between centres is useful in some cases, but the lack of vertical adjustment and height makes this method somewhat limited.

This horizontal milling attachment designed by J. Neave, for fitting to a centre lathe overcomes the limitation of lack of adjustment, whilst giving an additional 1½ in. of working height above the cross slide

This milling attachment has been designed to be mounted on any lathe of 3½ in. centre height and above. It has proved to be a very useful addition to my own machine, enabling a wide range of milling operations to be carried out quite successfully. The attachment has been relatively cheap and easy to construct, most of the material coming from the scrap box, plus a couple of simple castings. A motor is not required to drive it, since it is driven from the spindle nose of the parent machine and is therefore powered by the lathe's own motor and transmission system. A little ingenuity is required by the constructor to modify and position the trunnion carrying the leadscrew to match his own lathe.



Construction can be seen on the General Arrangement drawing. Two triangular shaped castings are clamped to an overhead bar to form a rigid but adjustable frame. The drive from the headstock is preferably by means of a collet. A chuck could be used but this would mean losing useful bed length. The arbor shaft carrying the cutters runs parallel to the drive shaft and is driven from it by Myford change wheels, in this case a 20 tooth driving a 40 tooth wheel, both shafts being located in the left hand casting in 0.75 in. dia. bores. The gears can be reversed, a 40 tooth driving a 20 tooth; any other pair of gear wheels having 1.5 in. between centres could be used.

The right hand side casting has two 0.75 in. dia. bores, one of which will locate on a tailstock adaptor, or direct on the tailstock barrel if this happens to be 0.75 in. diameter. The other bore contains a demountable arbor bush, this carries the right hand end of the arbor shaft. All four lower holes in the castings are 0.75 in. dia., this means that the drive shaft and the arbor shaft can be interchanged at the left hand end, and the demountable arbor bush can be changed over into the other bore at the right hand end. The arbor shaft can therefore be positioned 1.5 in. in front of, or behind the machine's centre line while the drive shaft remains on the machine centre line (see dotted detail showing alternative position on G.A. drawing).

Added advantage

Cutters can be changed, or the position of the cutter along the arbor shaft varied, while the attachment is mounted in the

General view of the Lathe Milling Attachment in position: on its parent lathe, a Cutter is mounted in the adaptor on the arbor. To the left of the saddle is the operating handle and lead screw.

lathe. The procedure is to first slacken the arbor nut, (while the arbor shaft is still supported at both ends). Unlock the tailstock from the bed, slacken the single screw locking the right hand casting to the overhead spindle, and slide the tailstock with the right hand casting still attached to it and still engaged on the overhead spindle to the right. The R. H. casting is drawn off the arbor shaft, the end of the arbor shaft is exposed, which leaves a gap available to change cutters, spacers etc.

Height adjustment

The height of the arbor shaft which carries the cutters is varied by rotating the frame supporting it about the centre line of the machine. This is done by means of a lever arm attached to the left hand casting carrying a cross head nut which is driven by a leadscrew operated by a handwheel. The leadscrew revolves through a pivoted bearing carried on a trunnion clamped in this case to the front spindle of the lathe bed. A 10 TPI leadscrew has been used, so that the handwheel boss could be graduated to read in 0.001 in. increments; this would only give a true reading when the arbor shaft was at lathe centre height. Slips or feeler gauges used between the cutter and the table is perhaps the best method. The lever arm is located on dowel pins and secured by a single screw on the left hand casting. It has 12 equi-spaced

Lathe Milling Attachment Item List.

	Description	No. Off	Remarks
1.	Housing R/H	1	C.I. Casting.
2.	Housing L/H	1	C.I. Casting.
3.	Spindle (Frame)	1	Silver Steel.
4.	Arbor	1	Steel (EN8).
5.	Drive spindle	1	Steel (EN8).
6.	T/S Adaptor No. 2MT	1	Steel (EN8) (If reqd).
7.	T/S Adaptor No. 3MT	1	Steel (EN8) (If reqd).
8.	Arbor Bush	1	Phos/Bronze.
9.	Thrust Washer	1	Phos/Bronze.
10.	Spec. Thrust Washer	1	Phos/Bronze.
11.	Adaptor Spigot	1	Steel (EN8).
12.	Adaptor Recess	1	Steel (EN8).
13.	Arbor Nut	1	Steel (EN8).
14.	Arbor Spacer 0.75	2	Steel (EN8).
15.	Arbor Spacer 0.50	2	Steel (EN8).
16.	Arbor Spacer 0.37	2	Steel (EN8).
17.	Arbor Spacer 0.25	2	Steel (EN8).
18.)			
19.)	Not used		
20.)			
21.	Lever Arm	1	Gauge Plate.
22.	Cross Head Nut	1	Phos/Bronze.
23.	Cross head Clamp	1	BMS.
24.	Lead Screw	1	Steel (EN8).
25.	Leadscrew Bearing	1	Brass.
26.	Hand Wheel	1	BMS.
27.	Not used		
28.	Trunnion	1	Aluminium Alloy.
29.	Special Washer	1	BMS.
30.	Not used		
31.	Pattern Housing	1	Timber.
32.)			
33.)	Not used		
34.	Key 0.25in. Lg.	2	Keysteel 0.125in. sq.
35.	Dowel Pin 0.75in. Lg.	3	Silver Steel 6mm Dia.
36.	Dowel Pin 0.50in. Lg.	2	Silver Steel 3mm Dia.
37.	Not used		
38.	Screw C/Hd M6x16mm	1	Steel.
39.	Screw C/Hd M6x12mm	1	Steel.
40.	Screw C/Hd M6x30mm	2	Steel.
41.	Screw C/Hd M6x40mm	4	Steel.
42.	Not used		
43.	Screw C/Hd M5x30mm	1	Steel.
44.	Plain Nut M6	1	Steel.
45.	Plain Washer M6	1	Steel.
46.	Plain Washer M10	1	Steel.
47.	Ext Circlip 0.62in.	1	Steel.
48.	Taper Pin No.4	1	Steel.
49.	20 Tooth Gear	1	Cast Iron*.
50.	40 Tooth Gear	1	Cast Iron*.

* Supplied by:- Myford Ltd., Beeston, Nottingham, NG9 1EH.

holes drilled in it to match the screw and dowel pin positions in the casting so that as the angular position of the casting changes, the lever arm can be repositioned in relation to it at 15 deg. intervals.

Machining Sequences

Items 1 & 2, Housings R & L/Hand

These notes and sketches describe the operational sequence adopted to machine these two castings on a Colchester Bantam lathe.

Set-up each casting in turn in a 4-Jaw chuck and machine off the minimum amount necessary to clean up the back face, see Fig. 1.

Machine the base of each casting in turn

to clean up. This could be done by clamping the castings to the cross slide, and using a cutter in the headstock to machine them. Mark out the centres of the main bores, drill and tap those required to match the holding down bolts used in later operations.

Set-up each casting in turn on a faceplate with the machined face to the faceplate, machine the front faces of the bosses to 1.5in. thickness, (Fig. 3).

Reposition the casting to bring the centre of the 1in. bore on the centre line of the machine; bore the 1in. dia. hole: repeat for the second casting, (Fig. 4).

Turn a locating button to be good fit in the 1in. bores, make it about 1/4in. thick with a holding down stud hole in the centre. Use this button to locate the casting in the correct position, shown in Fig. 5, by dimension X which equals 3.5795in. and bore one of the 0.75 in. dia. bores. Repeat with second casting but facing the opposite way i.e., bosses to the faceplate to make up a matched pair (Fig. 5). Turn a second button to suit the 0.75in. dia. holes and use this to position the second 0.75in. dia. bore in the correct position and bore it to size. Leave the two locating buttons in position on the faceplate. Set-up the second casting on the locating buttons but again facing the opposite way, i.e. bosses to the faceplate and machine its second 0.75 in. dia. bore to size (Fig. 6). This procedure should ensure a perfect alignment of the bores and shafts.

On both castings cut the slot through to the 1in. bores. Spot face, drill and then tap for the clamping screw. Centre drill and drill through at 0.093in. dia. for the oil holes (one to each 0.75 in. dia. bore).

Item 1 only

Spot face, drill and tap for the clamping screws. Next cut the slots; one for each of the 0.75in. dia. bores.

Item 2 only

Drill and ream the three 6mm dia. x 0.75in. deep dowel holes and tap the two M6 by 0.5in. deep locking screw holes; these holes must be positioned accurately to match the Lever Arm, Item 21 in both positions.

Spindle (Frame), Item 3

Machine to overall length as shown on the drawing or as required to suit any other lathe. Chamfer both ends.

Arbor, Item 4

Face both ends to length and centre drill. Set-up to machine between centres. As this is a rather long and slender shaft a travelling steady should be used. From the left hand end, machine the 0.7500/0.7495 in. dia., and then machine the 0.6247/0.6244 in. diameter. Reverse in the lathe, and machine the 0.6245/0.6240 in. dia. up to the

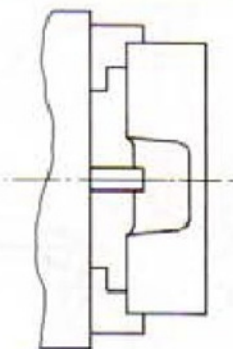


Fig. 1 Mount the castings in a 4-jaw chuck and machine the back face to clean up.

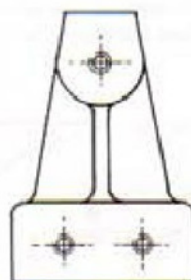


Fig. 2 Machine the base to clean up and mark out the positions of the three hole centres. Drill and tap to holding down bolt size.

0.125 in. thick shoulder. Make the 0.5000/0.4995 in. dia. portion 3.5in. long. Cut the 0.187in. by 15deg. chamfer. Screwcut the 1/4in. BSF L/H thread. Remove from between centres, hold in a four jaw chuck (protecting the shaft with foil), drill and tap the M6 x 0.5 in. deep thread. End mill the keyway.

Drive Spindle, Item 5

This drive spindle has been designed to be held in a collet, it could be held in a chuck, but this will reduce the usable bed length.

Face and centre drill one end. Rough turn the 0.75in. nominal dia. x 3.87in. long

The wooden pattern shown in the centre with the two unmachined castings on either side.



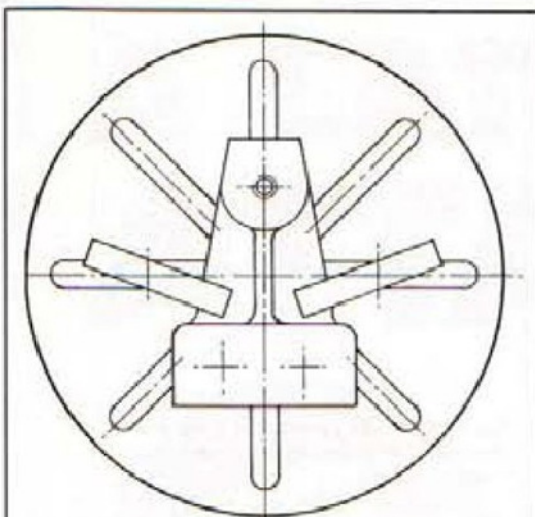


Fig. 3 Bolt from back of face plate. Clamp machined face to lathe face plate and machine front face parallel to back face

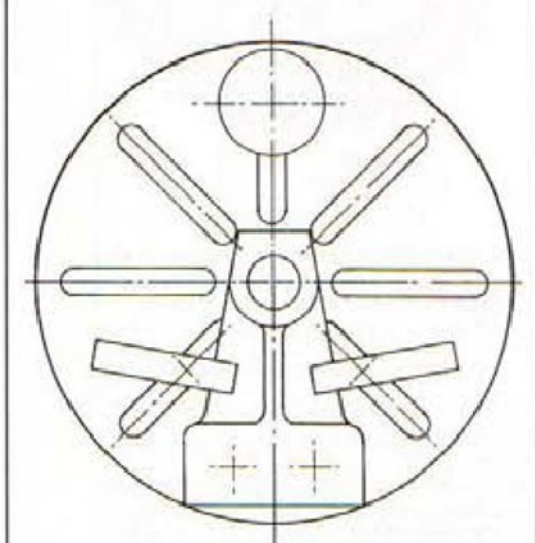


Fig. 4 Set one inch bore on centre line and machine to size (both castings).

and cut the undercut. Rough turn 0.625 in. nom. dia. by 2.25 in. long. Rough turn the 0.500 in. nominal diameter. Finish the 0.7500/0.7495 in. dia.; this must be a good running fit in the two 0.75 in. dia. reamed bores in the Left Hand housing, item 1. Finish turn the 0.6247/0.6244 in. dia. (push fit for the bore of a Myford change wheel). Finish turn the 0.500/0.499 in. diameter. All three of these diameters are important and must also be concentric to each other. Put in the circlip groove, and the 15 deg. chamfer at the end. Part off to 4 in. long. End mill the keyway groove.

Tail Stock Adaptor, No. 2MT, Item 6 or Tail Stock Adaptor No. 3MT, Item 7

Neither of these items will be required if the attachment is being fitted to a lathe with a tailstock having a 0.75 in. dia. barrel.

If the attachment is being fitted to a lathe with a No. 2MT then Item 6 will be required. An alternative design with No. 3MT (item 7) is included for larger lathes. It is possible to obtain Morse taper blanks which can be turned to suit. These are supplied in a soft condition and cost only a

modest sum; and this is obviously the easiest way to do the job.

If this proves difficult or impossible, whichever taper is required should be turned first, detailed instructions for this procedure have been discussed in several previous articles. Now, with the component mounted in the headstock spindle, turn the spigot to the dimensions shown on the drawing. The taper and spigot must be concentric to each other.

Arbor Bush, Item 8

Face ends to length, centre drill, rough turn the outside diameter. Drill and ream the centre hole to 0.5007/0.5000 in. diameter. Set-up between centres on a suitable mandrel. Finish machine outside dia. to 1.25 in. diameter. Rough down the 0.75 in. nom. dia., and undercut, machine the 1.12 in. dia. x 0.060 in. shoulder, finish machine the 0.7500/0.7495 in. diameter. Cut the 0.187 in. by 15 deg. chamfer. Drill the 0.25 in. dia. oil hole.

Thrust Washers, Items 9 & 10

Face and centre drill first end. Bore centre hole 0.755/0.752 in. dia. deep enough for both items (plus parting off). Cut the shoulder for item 10, 0.937 in. dia. by 0.030 in. long. Part off 0.125 in. thick. Part off for item 9, 0.125 in. thick.

Adaptor Spigot, Item 11, and Adaptor Recess, Item 12

These two items (11 and 12) together are designed to match a cutter having a 1 in. bore, as shown on the drawing, obviously a cutter with a 0.625 in. bore would not require an adaptor. For any other cutter with a different size bore an adaptor could soon be turned up to suit.

It is economical in both time and material to manufacture these two items together. Part off sufficient length to make both items plus a parting off allowance. Face and centre drill the first end. Bore the centre hole out to 0.6255/0.6250 in. dia., for both items.

For item 11, machine the spigot 0.9995/0.9990 in. dia. by 0.37 in. long, part off at 0.62 in. long.

For item 12 bore the recess 1.010/1.005 in. dia. by 0.37 in. deep. Part off to 0.75 in. long.

Arbor Nut, Item 13

Face and centre drill, drill tapping size for the thread, 14mm or $\frac{1}{2}$ in. diameter. Screwcut the thread, $\frac{1}{2}$ in. BSF, L/H. Turn the outside dia. 0.87 in. and part off. Mill the 0.752/0.750 in. across flats hexagon.

Arbor Spacers, Items 14, 15, 16 17.

Face first end and centre drill, turn 0.87 in. diameter. Bore the centre hole to 0.630/0.627 in. dia. and part off to length.

Lever Arm, Item 21

Apply marking blue and mark out the centre line of the plate; the two larger hole centres, and the outline shape. Set-up on a faceplate and bore the 1.06 in. dia. hole, leave the job on the faceplate. Transfer together if possible to a dividing head and drill the twelve 0.25 in. dia. holes at 30 deg. intervals. Remember that each pair of diametrically opposite holes must match the dowel pins in item 1 in both alternative positions and at the same time the hole at right angles to each pair must match the tapped hole position for the locking screw, so great care must be taken. Drill and ream the 0.625 in. dia. hole. Drill the two pilot holes 2.8mm dia. ready to be reamed 3.0mm dia. on assembly with the crosshead clamp, item 23. Drill and tap the M5 hole.

Finish the outside profile by bandsaw, mill or even by hacksaw and file.

Cross head Nut, Item 22

Machine to 1.12 in. dia. and part off at 1.125 in. overall length. Hold in a 4 jaw chuck with the axis vertical. Drill the tapping hole for the thread exactly on the centre line, 0.339 in. dia. (letter R drill). Screwcut the 0.437 in. x 10 TPI Acme Form L/H thread. This thread must be a good fit on the leadscrew, item 24, to minimise backlash. Set-up in the horizontal position again and turn the first spigot 0.624/0.623 in. dia. and its undercut. Reverse and cut the second spigot which must of course be concentric with the first.

Cross Head Clamp, Item 23

Machine to overall dimensions, 1.25 in. x 0.75 in. by 1.0 in. Machine the shoulder 0.503/0.502 in. and 0.312 in. Drill and ream the 0.625 in. dia. hole, drill the 0.203 in. dia. hole. Mill the 0.5 in. radius and the two 0.12 in. by 45 deg. chamfers.

Lead Screw, Item 24

It may be necessary to increase the overall length of this item, if the centre distance between the lathe bed and the trunnion has to be extended.

Face both ends to the overall length, 9.0 in., and centre drill both ends. Set-up between centres and machine the 0.62 in. x 0.312 in. dia. undercut 6.62 in. from the tailstock end. Machine the outside dia. of the thread 0.437 in. dia. and screwcut the thread, 10 TPI L/H Acme form, root dia. 0.317 in., use a travelling steady and try to get a good fit in the matching piece item 22 the Cross head nut. Reverse in the lathe and chuck on the thread, first protecting it with foil, support the other end with the tailstock centre. Turn the outside dia. of the M6 thread and its undercut, and then cut the M6 thread, followed by the 0.3789/0.3745 in. dia. and its undercut.

Lead Screw Bearing, Item 25

Face and centre the first end. Rough turn the 0.374/0.373 in. dia. and undercut. Turn the outside dia. of the M6 thread, machine the undercut, and machine the thread. Finish turn the 0.374/0.373 in. diameter. Part off to length, machine the two flats and bore the 0.375 in. dia. hole.

Hand Wheel, Item 26

Face the first side and machine the boss 0.62 in. dia. by 0.937 in. long. Drill the tapping hole for the M6 thread 5.1 mm diameter. Drill and ream the 0.375 in. dia. hole (push fit for the Lead Screw, item 24) by 0.937 in. deep. Reverse in the machine and hold on the boss, face to 1.31 in. length, tap the centre hole M6. Diamond knurl the outside diameter. Drill and tap the M6 hole, tapping drill 4.3 mm diameter, position 0.812 in. radial distance from centre line.

Handle

Face end and cut the shoulder 5 mm dia. x 0.37 in. long, cut the thread M5, face to length and chamfer end.

Assemble the Hand Wheel and its Handle together.

Trunnion, Item 28

The design of trunnion shown in the drawing is to match a particular lathe design. The design of this item would have to be modified to suit the actual lathe for which it is intended. The position of the Trunnion along the bed is important, since the leadscrew must be square across the bed to function correctly. There can be a fair amount of latitude in the distance from the centre line of the lathe bed to the centre line of the trunnion; but if it is much greater

the length of the leadscrew (item 24) might have to be increased proportionately.

Machine to overall dimensions 0.75in. x 2.5in. x 4.0 in.. Bore the 1.500in. dia. hole to be a slide fit on the lathe bed front spindle. Drill and ream the 0.375in. dia. hole at 2.50in. centres. Centre drill and drill the 0.062in. oil hole through into the centre bore. Machine the two top shoulders 0.75in. x 2.0in. long and the lower shoulders 0.25in. x 0.5in. wide. Drill 5.1mm tapping size holes through both A and B. Separate parts A and B on the centre line of the 1.5in. nominal bore using a 0.062in. slitting cutter. Tap the 5.1mm holes in part A, M6. Open out the 5.1mm dia. holes in part B out to 0.25in. diameter.

Special Washer, Item 29

Face and centre drill, drill through 0.25in. dia., part off to 0.09in. thickness.

Pattern Housing, Item 31

Part A can be cut from "0.5" plywood which is usually about 0.43in. thick, the profile shape is shown in the lower view. Part B can be made from a rectangular piece of wood with a 5 deg. draft angle added as shown. Part C is a shaped block prepared in a similar manner to part B. Part D can be turned as a truncated cone, included angle 10 deg., and cut in half along its axis. These three pieces should be pinned and glued to part A. Part E should then be cut to fit in between the two bosses and glued in position. Filler can then be used to form the fillet radii where shown. Rub down to a smooth surface and paint with undercoat.

Assembly of the milling attachment

Before starting the actual assembly a few preliminary checks on various components will save time and trouble at a later stage. Check that the two housings (left and right hand), items 2 and 1, when

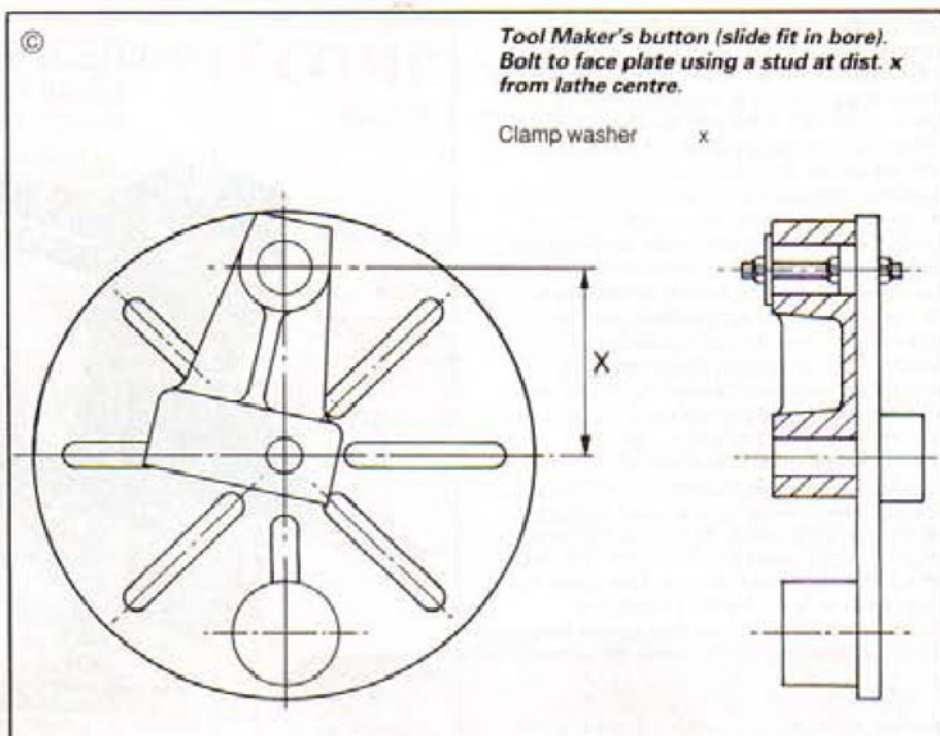


Fig 5 Set first 0.75 inch hole in line with lathe centre line, clamp and machine bore to size. Set up the second casting as above but facing in the opp. direction to make a matched pair and machine its bore.

fitted on the spindle frame, item 3, will lock solid when the lock screw, item 40 is tightened and that the Housing right hand will slide freely when the screw is released.

When these conditions have been met, dismantle these parts.

Check that the Drive spindle, item 5, and the Arbor, item 4, will both revolve freely without play in either of the 0.75in. dia. bores in the Left Hand Housing item 2. Having completed this check fit the three 6mm dowel pins, item 35. They should be pressed in, leaving a height equal to the thickness of the Lever Arm, item 21, above the machined surface (see drawing). The Lever Arm, item 21, should be tried on each 0.75in. diameter bore in various alternative positions on the dowel pins, with the screw, item 39 tightened. The Drive shaft item 5, and the Arbor item 4, should be in position, and in reversed positions during this trial, see drawing.

Check that the Arbor bush, item 8, will run freely without play on the small end of the Arbor, item 4. Then check that the same item 8, will slide into both 0.75in. dia. bores of the Housing, right hand, item 1, and will lock in both bores when the screw, item 41, is tightened. Similarly, check the Tailstock Adaptor, item 6 or 7, in both bores in the same manner.

Fit the Drive Spindle, item 5, into the Housing Left Hand, making sure the Housing is the right way round, see drawing. Fit the Special Thrust Washer, item 10, making sure it is the correct way round (see drawing). Fit one of the keys, item 34, into the keyway and then fit the 20 tooth gearwheel item 49. Fit the external circlip, item 47, into its groove. Make sure the Drive Shaft still revolves freely without play, and make adjustments if it does not.

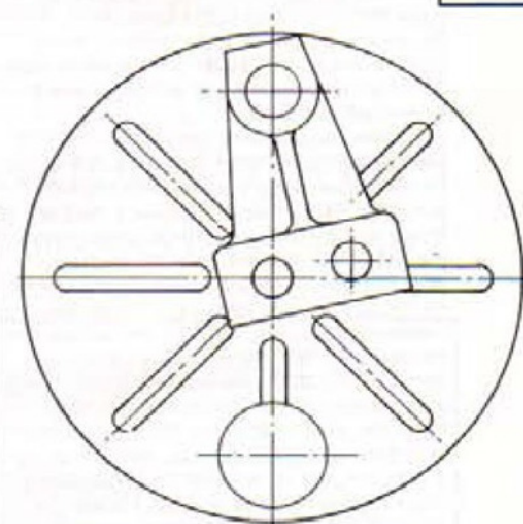
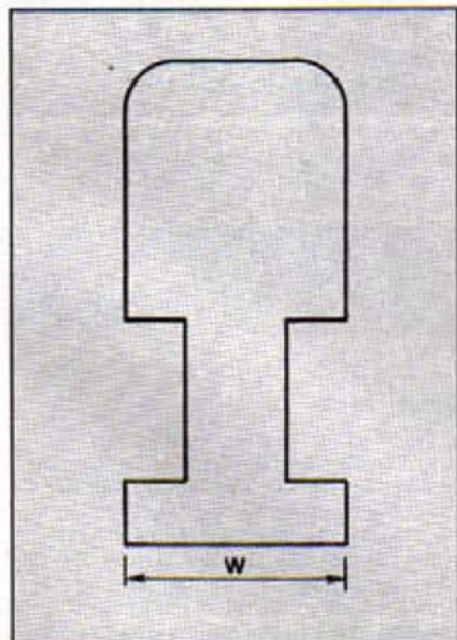


Fig 6 Fit a second smaller toolmaker's button to the face plate in a position to place the second 0.75 inch bore in line with the lathe centre line. Machine the second 0.75in bore in each casting.

Next insert the Arbor, item 4, into its bore. Fit the thrust washer, item 9, and the key, item 34, into its keyway. Fit the 40 tooth gearwheel, item 50, which should slide into engagement with the previously fitted 20 tooth gearwheel. Fit the special washer, item 9, to the MS x 12mm screw, item 39, and screw this into the end of the Arbor, item 4. Make sure the two shafts now revolve together freely without play. The assembly should now be continued in the lathe on which it is to be used. The means selected for driving the attachment should now be placed in position at the headstock end of the machine, i.e. either, a 0.500in. dia. collet, or a chuck. If required fit the Tailstock Adaptor, item 6 or 7, in position on the tailstock barrel. Place the Arbor bush, item 8, into the Housing Right Hand, item 1. Slide the Spindle Frame, item 3, into the top bore of the Housing Left Hand, item 2 and lock it in the position shown with the screw, item 40. Slide the Housing



SWarf REMOVAL FROM TEE SLOTS

Make up a tool as shown out of 1.6mm mild steel sheet (mine is galvanised). The tee end (W) is cut to the width of the slot. The other end can be used as a small trowel to lift out the swarf from the end of the milling table. The two radii match the casting fillets.

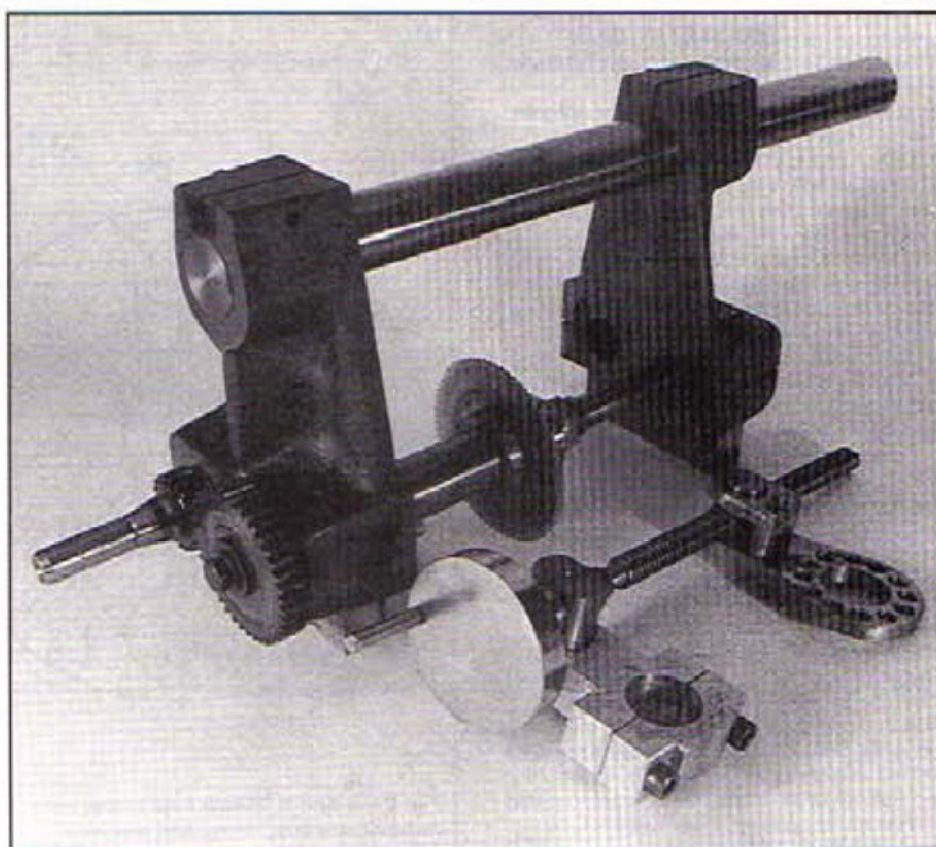
Right Hand, item 2, into position on the Spindle (Frame), item 3, shown in chain dotted detail. Do not engage it on the Arbor at this stage, lock it in the approximate position shown. Offer the attachment to the lathe and engage the Drive Spindle, item 6, with whatever form of drive is chosen. Feed the tailstock barrel forward to engage in the Housing Right Hand, item 1 (still in the chain dot position shown), and lock the screw, item 4). Now unlock the tailstock from the bed, unlock the top screw, item 40, and slide the tailstock and Housing Right Hand towards the headstock. If everything is in correct alignment, the Arbor, item 4, should slide into the Arbor Bush as shown on the drawing. Tighten the top housing left hand screw, item 40. Relock the tailstock to the bed.

Take the Lever Arm, item 21, which has already been checked for correct fitting to the left Hand Housing, item 2, and fit one spigot of the Cross Head Nut, item 22, into the 0.525in. dia. reamed hole (see drawing, scrap section X-X). Fit the Crosshead Clamp, item 23 over the other spigot and resting on the lever arm, fit the M5 screw, item 43.

Tighten up with item 43 in the correct position. Spot through with a 2.8mm drill from the pilot holes in the Lever Arm, item 2), ream the two 3mm dia. holes. Fit two 3mm x 0.5in. long, silver steel dowels, item 35. The Cross head must of course pivot freely without play.

Fit the Leadscrew bearing, item 25, into the reamed hole in the Trunnion, item 2a. Fit the MS washer, item 45, and the MS nut, item 44. The bearing should revolve freely in the Trunnion without play. Place the M10 steel washer, item 45, in the position shown on the Leadscrew, item 44. Fit the Leadscrew, item 24, through the Leadscrew bearing, item 25, and screw the Handwheel, item 25, on to the Leadscrew, item 24. Adjust the handwheel to run freely without play in the Leadscrew Bearing. From the pilot hole to the Handwheel boss drill through the leadscrew, item 24, using a 0.0713in. dia. drill; ream through with a taper pin reamer and fit a No.4 taper pin, item 48. Screw the Leadscrew, item 24, through the crosshead nut, item 22, to the approximate position shown on the assembly drawing.

Returning to that part of the attachment already assembled on the lathe, hold the Spindle (Frame) securely, release the screw, item 41, which locks the right hand Housing, item 1, to the barrel, item 7. Carefully rotate the attachment about the machine centre line until it is in the



This picture shows the construction of the adjustable frame. On the left is the drive spindle and connecting gears to the arbor. In the foreground is the operating mechanism with the leadscrew, trunnion and lever arm.

approximate horizontal position shown on the drawing. Relock the screw, item 41, thus locking the right Hand housing to the Barrel, preventing the attachment from rotating.

Remove the Trunnion cap (item 25, part B). Offer the leadscrew sub-assembly across the lathe bed under the Left Hand Housing; engage the Lever, item 21 in the position shown on two of the dowel pins and secure it with the screw, item 38. The position of the Trunnion along the bed is obviously important since the leadscrew must be square across the bed to function correctly. There can be a fair amount of latitude in the distance from the centre line of the lathe bed to the centre line of the trunnion, since the length of the leadscrew is quite generous, if however, the attachment is to be fitted on a large lathe the length of the leadscrew might have to be increased. The screw locking the right Hand Housing to the Barrel (or tailstock adaptor) can now be slackened off and the Handwheel used to elevate or lower the Arbor. The machine should now be turned over slowly by hand to make sure everything is correct.

Assuming it is, lubricate the bearings and gears and try it under power at low speed to start the running in process. To load a cutter on the Arbor, unlock the top screw, item 40, in the right Hand Housing, unlock the tailstock from the bed; slide the tailstock together with the right Hand Housing to the right hand end of the bed until the right Hand Housing is in the position shown in chain dotted detail on the drawing. Thus the weight of the

attachment is well supported at both ends, but the end of the Arbor is exposed. Any spacers, items 14-17, and adaptor parts items 11 and 12, if required, a suitable cutter, and of course the Arbor nut, item 14, can now be placed in position on the Arbor. Do not attempt to tighten the Arbor nut at this stage whilst one end of the Arbor is unsupported, it could result in a bent arbor shaft. The tailstock can now be slid back to its original position with the right Hand Housing engaged on the Arbor, the tailstock should be locked to the bed, and the Right Hand Housing locked to the Spindle frame. The Arbor Nut can now be tightened with both ends of the Arbor supported in its bearings.

The height of the cutter can be accurately set by using slips and/or feeler gauges on the cross slide or by means of a vernier height gauge measuring from the surface of the cross slide to the top of the Arbor.

Safety hints

When using the tool in the lathe, remember to wind the cross slide outward when cutting, take up any slack before starting the cut, and if at all possible nip the gib adjusting screws up to allow a firm movement, all of which will help in preventing snatch. Remember to hold the work securely to the table, the forces involved in the use of quite a small horizontal cutter will considerably greater than those involved when using an end mill or slot drill.

Do remember to wear safety glasses, normal when operating the lathe, vital in this application. A stiff brush to clear the chippings before handling the work is advisable - chippings are sharp and once they have penetrated the skin, splinter style, can be the very devil to remove. A tiny wound will hurt out of all proportion to the injury!!

SHARPENING SMALL DRILLS

To assist in being able to see the end of a small diameter twist drill so it can be sharpened on a bench grinder I set up an Omnimag magnification lens mounted on a helping hand.

These lens are sold in Australia by Cigweld and are normally fitted behind the filter of arc welding helmets to assist older welders' vision. They are made of plastic and have four ranges (1.50mm, 2.00mm, 2.25mm and 2.50mm diopter). I believe that Cigweld is a subsidiary of BOC so the lens should be available in Britain.



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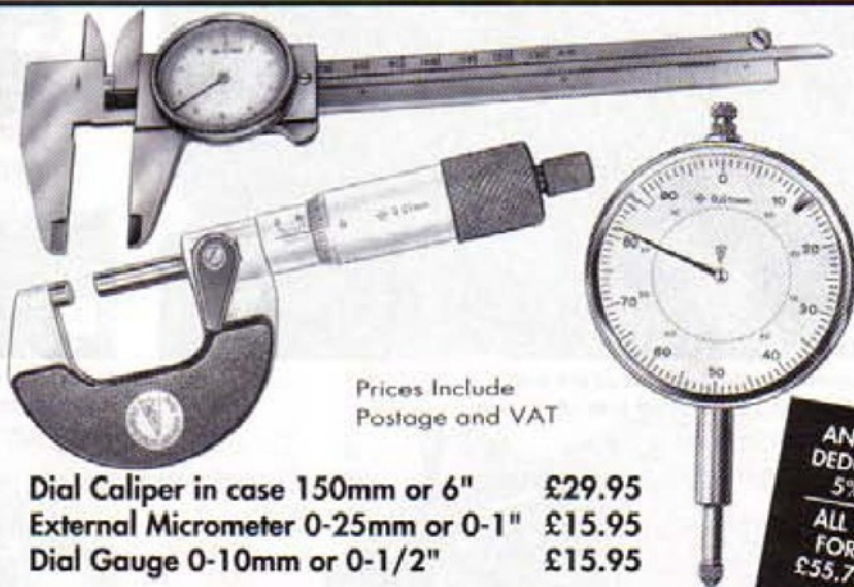
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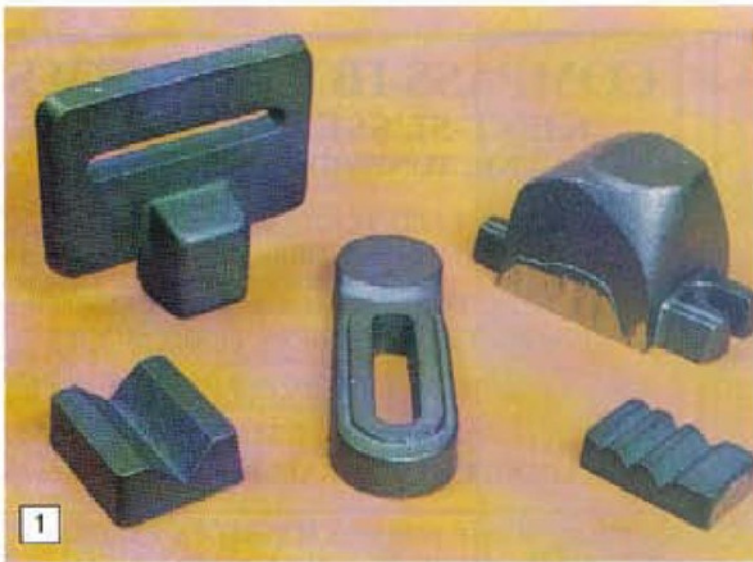
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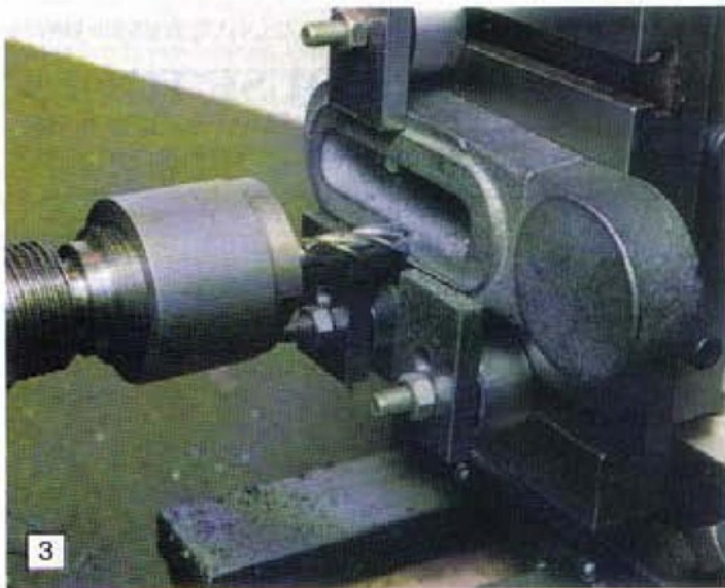
2

1: The set of five castings as supplied.

2: The completed grinding rest.

PART 1

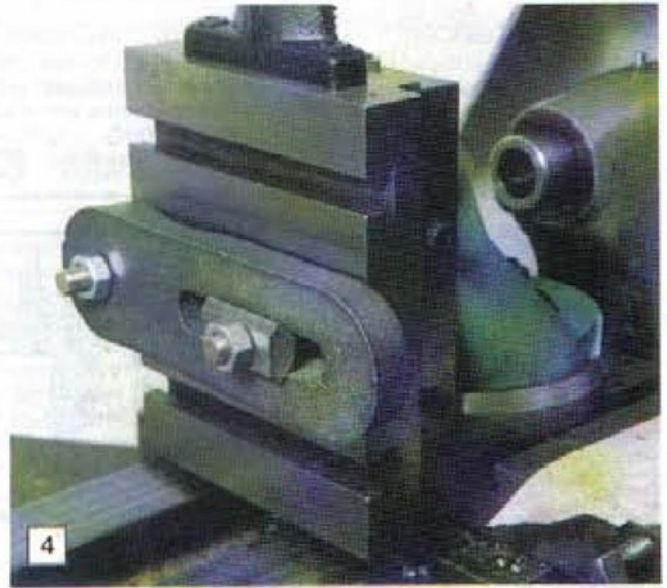
THE HART MULTI PURPOSE GRINDING REST



3

3: Machining the first face of the arm.

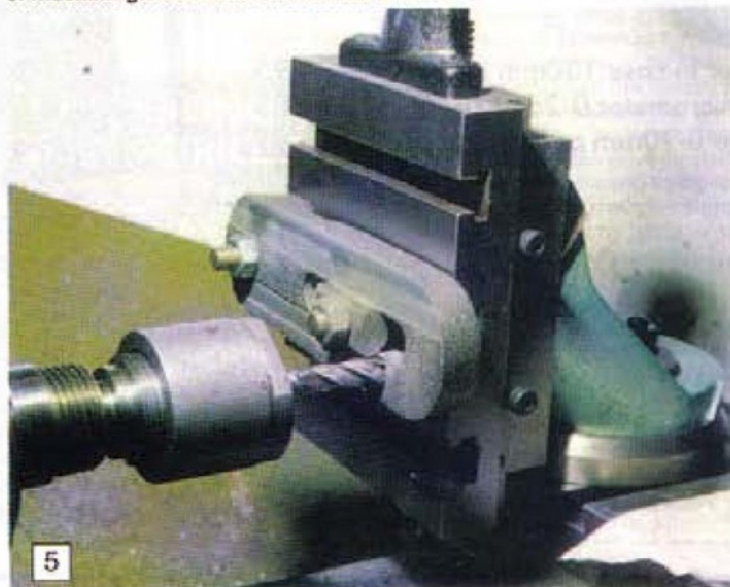
5: Machining the second side of the arm.



4

4: The arm fixed in preparation for machining the second side.

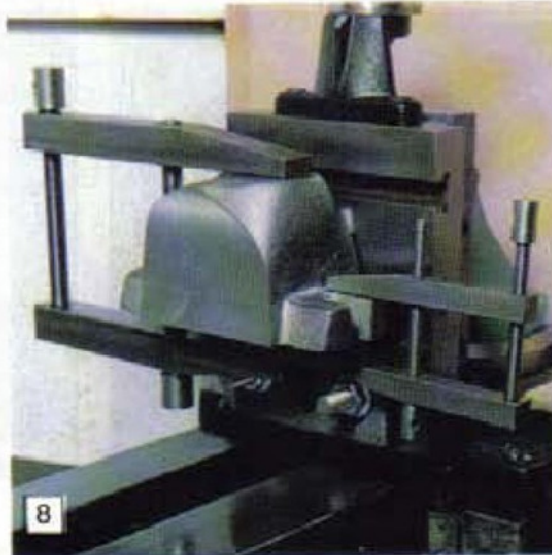
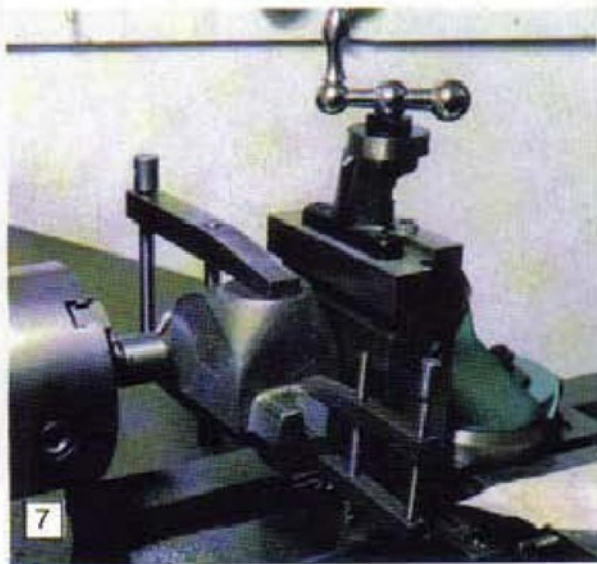
6: Boring the large hole in the arm.



5



6



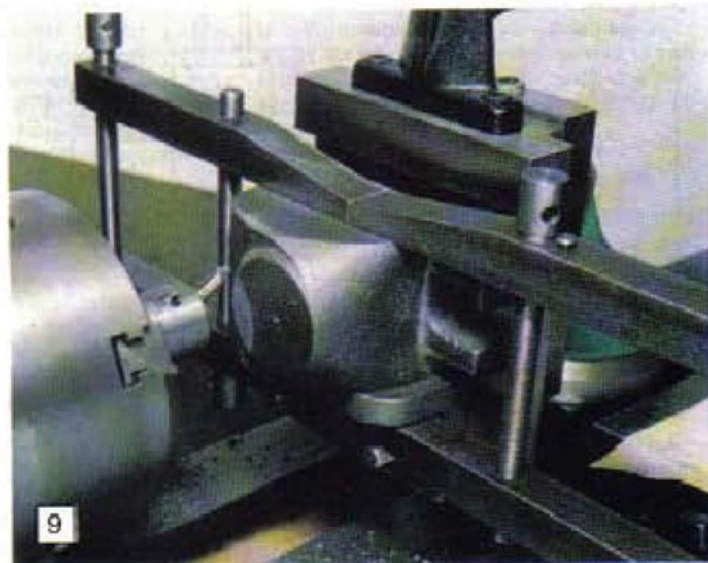
7: Showing how the base is held for machining the sides.

8: Machining the first side of the base.

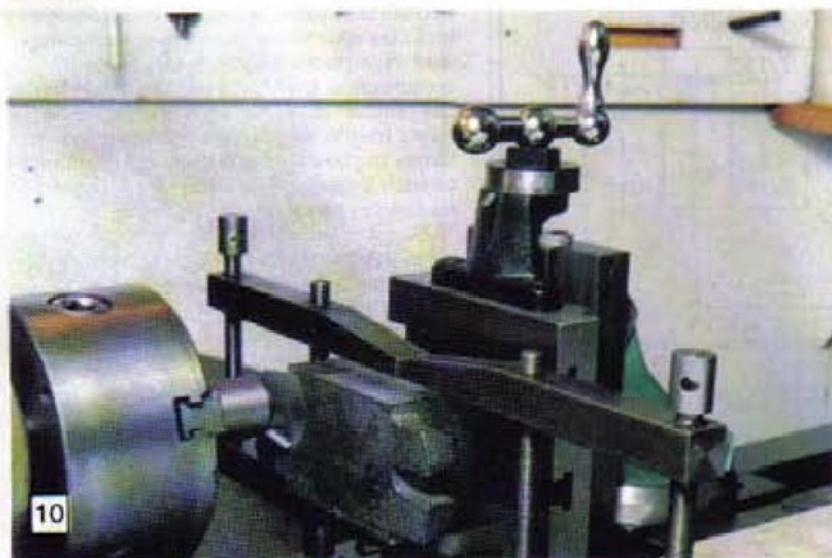
9: With both of the sides machined, holding the base for machining the top becomes easier.

If you, like many readers of *M.E.W.*, have problems with keeping workshop tools sharp, then the Hart multi purpose grinding rest is well worth your serious consideration. Having the capability of sharpening lathe tools, end mills, slot drills, slitting saws and even twist drills, though not conventionally, it is a true general purpose sharpening aid. In this article, it is made on a 3½in. centre height lathe, using a swivelling vertical slide for the required milling operations. The article will be of particular interest to the many readers who carry out their milling operations by this means.

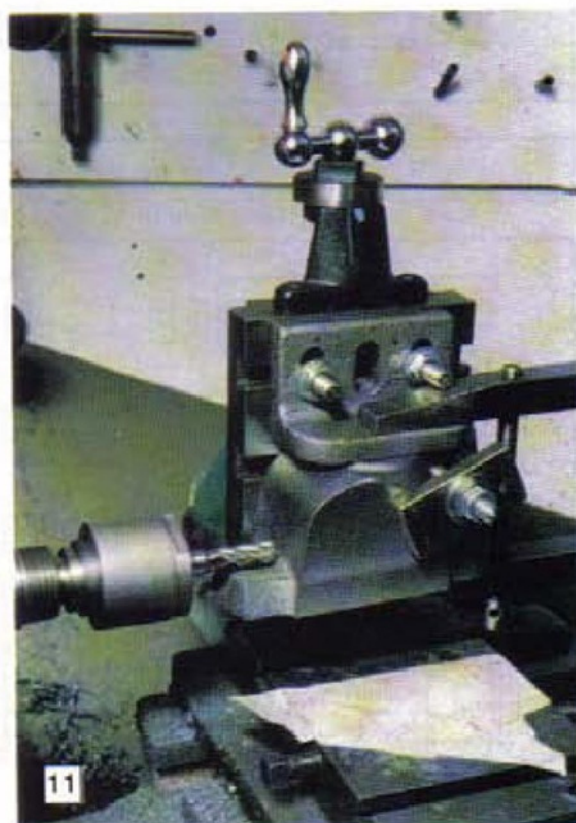
As well as being a detailed instruction for making the Hart, the article is also intended as a lesson in milling using the lathe, it is therefore extensively illustrated. The article is in two parts.



11: Milling the fixing lugs.

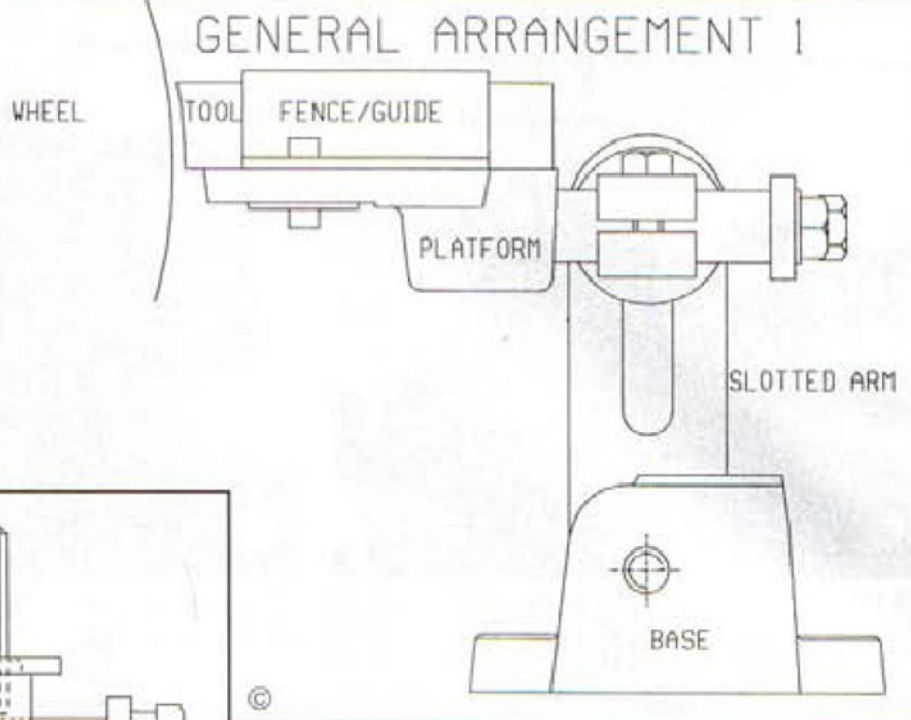


10: Machining the bottom of the base.

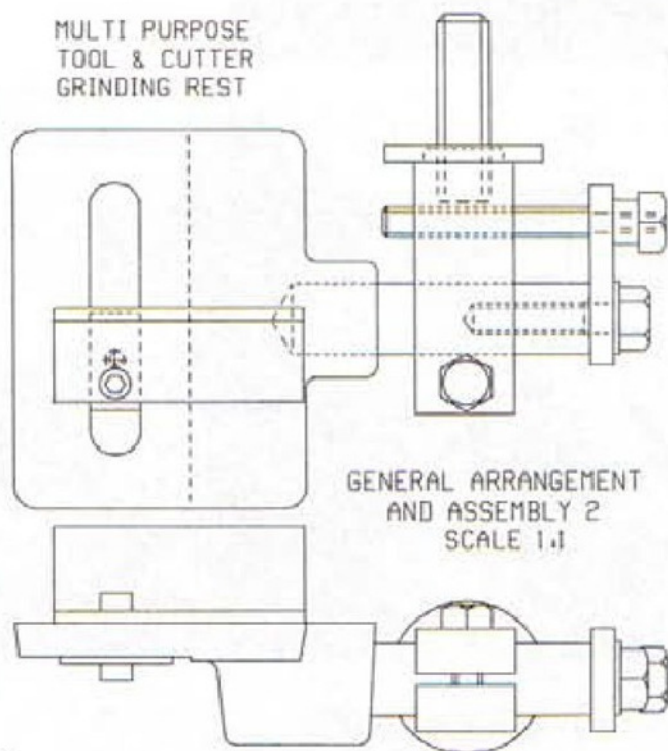


TAPPING BLIND HOLES

There is always a problem of swarf collecting at the bottom of the hole while tapping. All too often the component is too large to turn upside down and using compressed air to blow it out is quite dangerous. A technique I use successfully for holes 1/4in. dia. and larger is to fill the hole with grease (wheel bearing or similar). As the tap enters the hole the hydraulic action of the grease forces the swarf up the flutes.



MULTI PURPOSE TOOL & CUTTER GRINDING REST

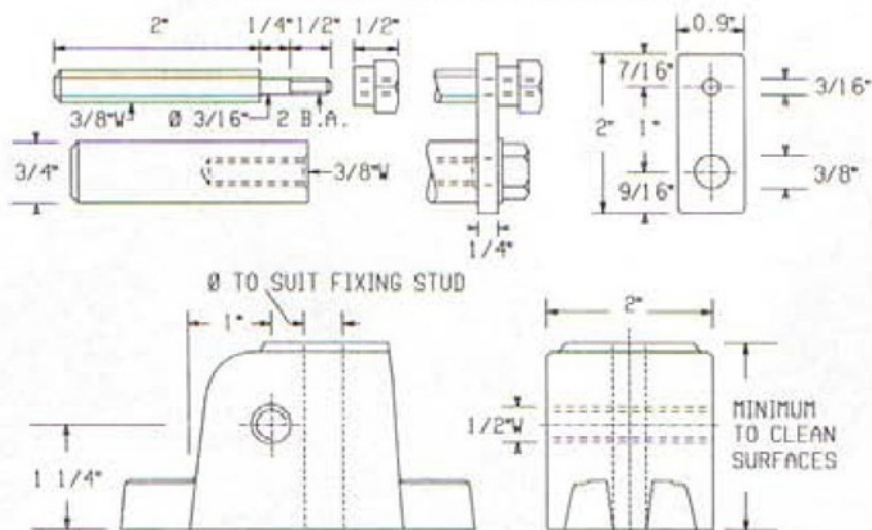


©



12: With the base having a substantial centre mark, it is used to hold the base in position for fixing.

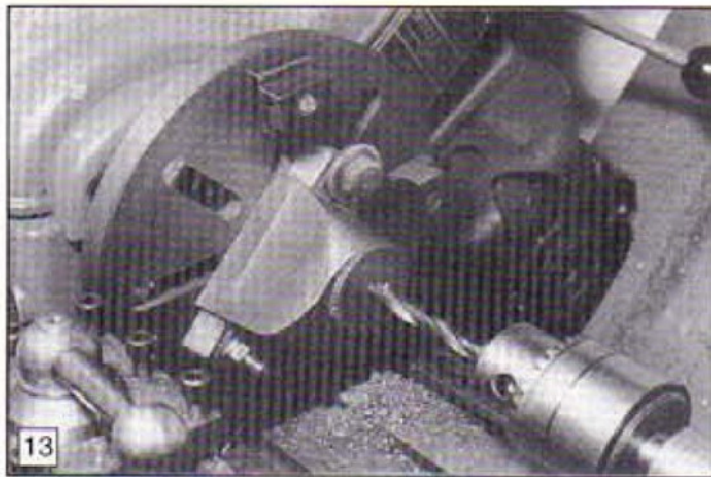
PLATFORM ADJUSTERS AND BASE CASTING



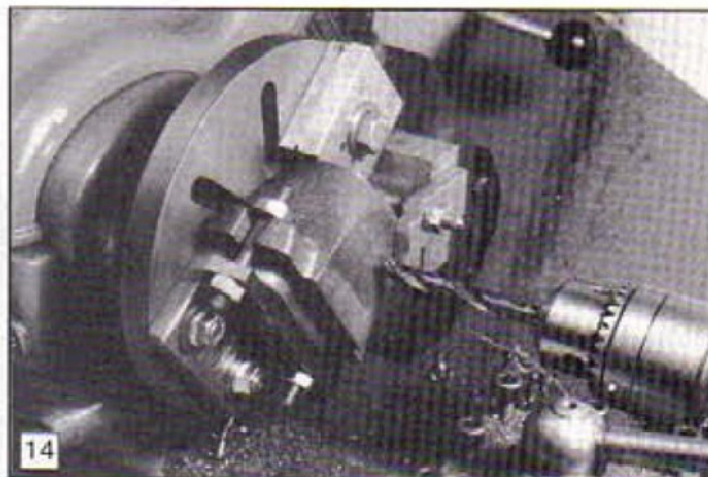
©

The Hart multi-purpose grinding rest, supplied in kit form, has recently been re-introduced to the market. This in the form of three main castings and two smaller ones, **photo 1**. The package includes all required materials, including: screws, nuts and washers etc. The construction is very robust, perhaps a little over robust in places. This is better than being fragile, which would make it too flimsy to provide the precise result required of such a device. The completed rest can be seen in **photo 2**.

Some of the thread sizes are also rather large, typically 1/2in. BSW; as a result, in my case, taps were not available. In view of this the sizes quoted on the drawings were reduced a little and made to metric sizes, M8 and M10. Readers who have the larger size taps can make to drawing, as all the necessary screws, nuts and washers are provided for these sizes. The drawings published with this article do not reflect the changes that were made to the grinding rest, but are as those supplied with the kit. Drawings for a few of the smaller items have been omitted. The drawings are adequate, but do leave a little more to the interpretation of the maker than is normal.



13: The base having been fixed, the hole is drilled.



14: Drilling the hole through the sides of the base.

with drawings in *M.E.W.* This should present no problem.

Also supplied is an 8 page instruction book detailing the use of the finished tool. This includes, the sharpening of common and not so common lathe tools, complete with details of the angles that should be ground for the differing applications. The rest can also be used for sharpening endmills, slot drills, slitting saws and even twist drills, all of which are explained in the instructions. In the case of twist drills, the method makes only the cutting edge, ensuring that both sides are equal, additional clearance if required can easily be done by hand.

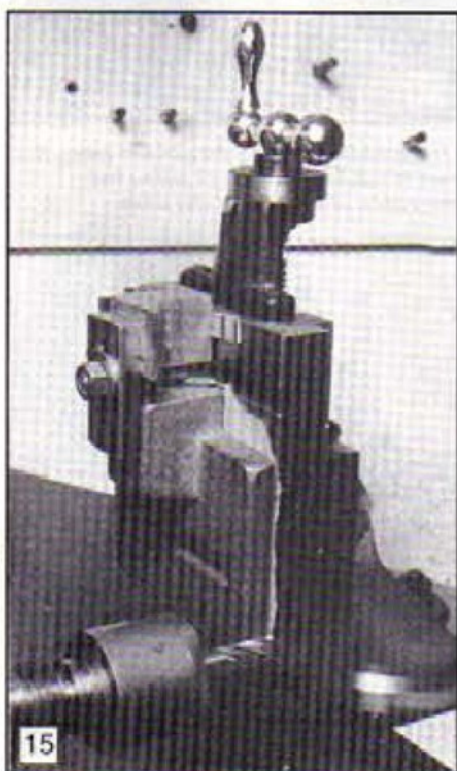
To complete the documentation supplied there are instructions for making the rest and a parts list. The parts list, details the complete kit in 7 packages, which is how it is supplied. This all adds work on the part of the suppliers and must increase their costs, as do the Allen keys supplied. Surely all workshops have a set of Allen keys? So many things are supplied with Allen keys that I now have a large

number doing nothing.

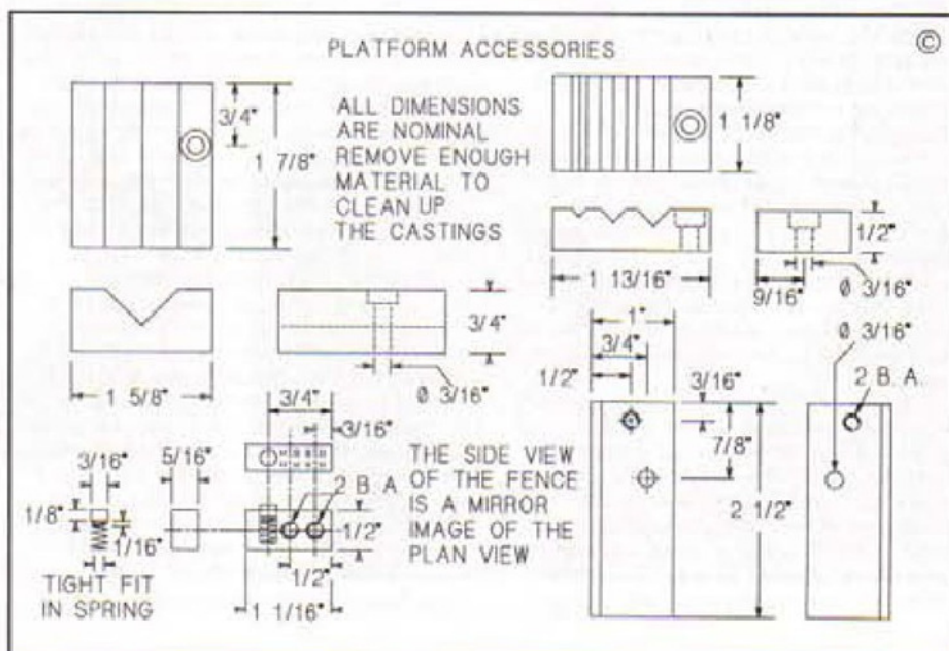
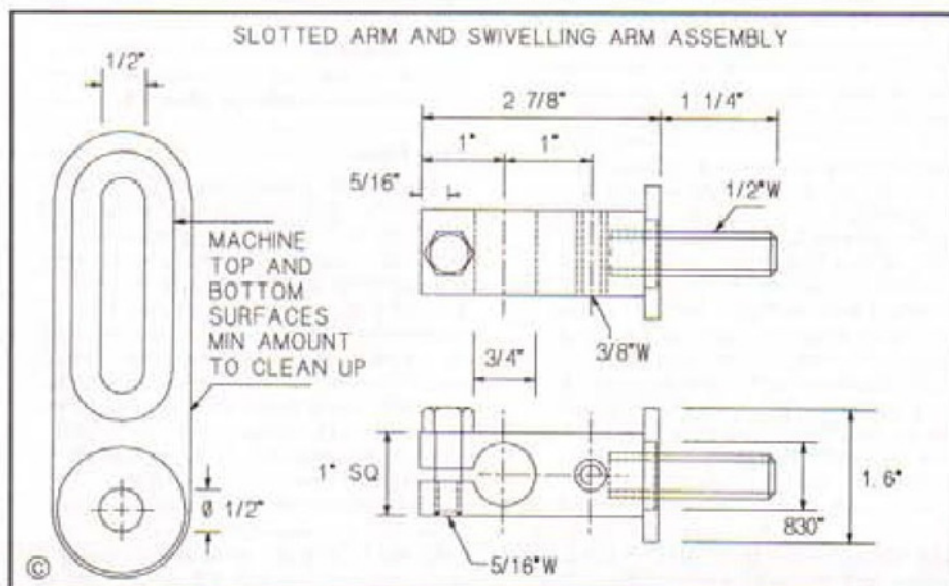
The manufacturing instructions supplied assume that the rest will be made using only a 3 1/2 in. lathe and a small drilling machine. Whilst some milling operations are done on the lathe these assume that a vertical slide is not available.

The majority of articles published in *M.E.W.* in the past appear to have assume that the reader has access to a milling

machine, and examples of items being made using the lathe fitted with a vertical slide have been few and far between. This is unfortunate, for I am sure there are still many for whom this is the only way to carry out milling operations. I am assuming the reader is in possession of a swivelling type vertical slide. The fixed type will additionally have to be removed and repositioned several times during the



15: Set-up for milling the edges of the table.



carrying out of the machining sequences described in this article.

To help redress the balance this tool is seen being made using only the basic tools assumed, and because of this it is generously illustrated. The method therefore also differs from that proposed by the supplier, Hart Engineering, Greenfield House, 19 Greenfield, Rhosddu, Wrexham, LL11 2NR.

Manufacture

Slotted arm

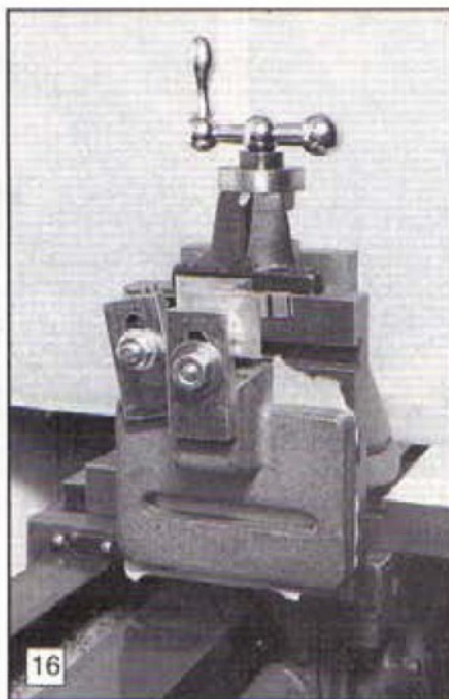
In many cases, the greatest difficulty when machining a casting is, because of its irregular shape, the holding of the part on the machine table. This problem is frequently greater when the machining is to be carried out on the lathe, due to the limited space available on a typical vertical slide. The castings for this grinding rest are no exception; in addition to their shape, the base and table are also nearing the size limit that is practicable when using a vertical slide on a 3½in. lathe.

First check that the larger face of the slotted arm will sit on the slide table without rocking, if not, the face must be dressed with a file so that the arm sits firmly prior to clamping. It is frequently considered that should a casting not sit firmly, it will be distorted and the eventual surface after machining not be flat. This is true, but when clamped to the relatively light table of a vertical slide, compared to a milling machine, some distortion of the slide may also take place, and as a result the slide may become stiff to operate.

When confident that the casting is sufficiently flat, fix it to the vertical table as seen in **photo 3**, then machine round the slot and also face the boss. Readers may be a little puzzled by the method of clamping seen in the photo, but I will not attempt to describe it here as it was the subject of an article in the last issue (*Faceplate/Angleplate Clamps*, page 24, Issue 20). The method is very suitable for use in confined spaces, such as a vertical slide, faceplate or angle plate, so do consider the article seriously.

With the first side machined, the second side has to be machined over its complete face, making it impracticable to hold using clamps as in the previous operation. This is a good example of the problem of holding irregular shaped castings. The slot is already ½in. wide to take the ½in. BSW stud (replaced by M10 in this case) so there is nothing to machine away that may permit an edge on which a clamp may rest. However, the slot is about ⅜in. undersize on this face due to the draft (taper) of the casting, this will require opening up slightly using a file, so the following approach can be adopted. Cut a piece of ⅜in. square mild steel, about 1½in long, and mill one corner away to make it almost triangular, it is then drilled diagonally to take an M8 screw. The boss of the casting is also drilled to take M8 and then fixed to the vertical slide as seen in **photo 4**.

The face of the casting is then end milled as shown in **photo 5**. Machine close to the nut and also to within ⅜in. of the slot, at the same time milling the corners of the clamping piece, as can be seen in the photograph. The slight web left along the length of the slot can be removed when the slot is finally cleaned up, a small chamfer will help to remove any trace left. The non-



16: Showing the second clamp, not visible in photo 15. Always use more than one clamp for milling operations.

machined portion under the nut will be removed when the hole is opened up on the faceplate, as seen in **photo 6**.

The base

Once again a reasonably flat surface is required so that the base can be clamped firmly for its first machining operation. Individual readers may choose to machine the casting in a different order, but the following approach is suggested. First ensure the bottom is sufficiently flat, with this done fix an angle plate to the bottom end of the vertical slide, clamping the base onto this, using toolmakers clamps as seen in **photo 7**. The angle plate used was a little on the small side and one slightly larger should be used if available.

The casting, has quite a taper on both sides, the side nearest the vertical slide will only rest against the slide at the lower edge of the casting. For added support, drop a piece of ⅜in. strip between the casting and the slide; let it drop to its natural position. Tap it a very little lower using a screwdriver, or similar wedge shaped tool, so as to give the casting a little more support, this can just be seen in **photo 7**, (after machining). Machine the side using a small fly cutter as shown in **photo 8**, then remove the casting, rotate and fix in the same manner for machining the opposite side. With the first side having been machined it will now rest precisely against the slide face.

With both sides now machined, clamping the casing securely in place for machining top and bottom will be very easy. First machine the top as in **photo 9**, then with the top placed firmly against the slide face, machine the base as in **photo 10**.

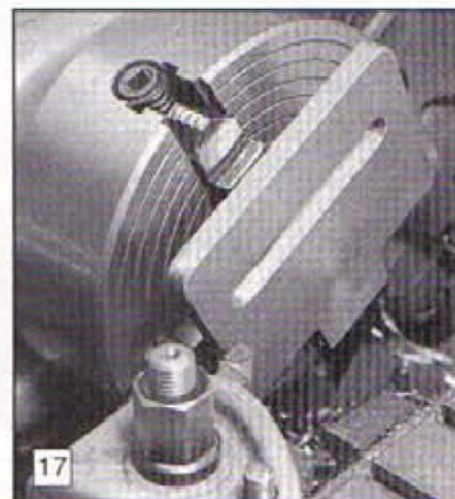
There remains one milling operation to be carried out; that of facing the fixing lugs. Unless a long series endmill is available it will be impossible to get to these surfaces with the end of the cutter, so the face must be machined using its side. To achieve this, turn the slide through 90 deg. so that it faces forward, with the base mounted as

seen in **photo 11**.

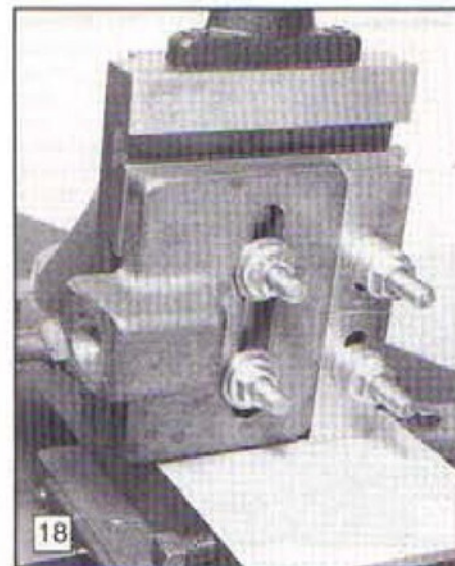
It remains to drill the holes, one down through the casting for an alternative fixing and the other for the ⅜in. BSW tapped hole (M10 in my example). These were produced on the lathe and **photos 12, 13 and 14** show how this was done. **Photo 12** shows how, with a generous centre punch mark where the hole is required, this is used to locate the casting on the face plate prior to fixing. This is a weighty casting so it is essential that the assembly is balanced by the addition of extra items on the faceplate, as seen in photos. Take the tension off the drive belt to allow the spindle to rotate freely, with this done adequate balancing can be achieved. If you have a substantial pillar drill these holes can be drilled on that machine.

The table

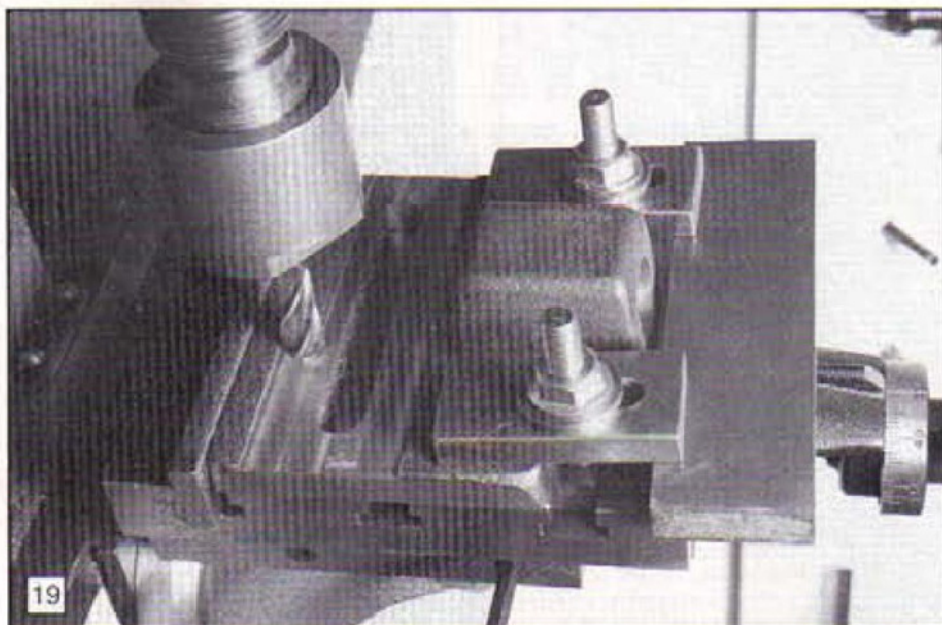
Of the three main castings only the table remains. This presents its own problems with regard to holding it for machining. More about that later. Return the vertical slide to the lathe, mounting the table as in **photo 15**, ensure that the slot is horizontal. The drawings do not call for the table edges to be machined, but I suggest this is done. I make this suggestion not only for appearance sake; it is possible that



17: Machining the top face of the table. It is held in the four jaw chuck using the projection at the rear of the table.



18: Boring the ¾in. dia. hole in the table.



19: Facing the rear of the table. Ensure the slide is accurately positioned; it is essential that table is the same thickness over the complete surface.

the accurate edges may prove useful as a guide during sharpening operations, or as an aid to setting up. Machining the three sides and the slot, without removing and repositioning the table on the slide, will ensure these are accurately parallel or at right angles. Add a thin piece of card between the casting and the surface of the vertical slide to allow machining to the back edge of the casting without damaging the slide face.

Never, unless it is practically impossible, attempt to machine a casting, such as the table casting, using only one clamp, as would appear to be the case in the photograph. **Photograph 16** shows that an additional clamp was in position on the blind side of the projection.

It had been considered that having machined the three edges, this would help when holding the table in the four jaw chuck; which is the suggested method by the supplier. It was found that this requires

a chuck with jaws that project by quite a lot, because of the extension on the back of the casting. The 6in. four jaw chuck available did not have deep enough jaws. I doubt if many of that size would be suitable.

The generous draft on the extension piece would appear to preclude any attempt to hold the table from this section. However, after much thought this still seemed the only possibility, and the following approach was adopted. Take a strip of soft copper, or aluminium, about $\frac{1}{8}$ in. wide by 4in. long and $\frac{1}{2}$ in. to $\frac{3}{4}$ in. thick and wrap it around the projection. Now place the projection of the table into the four jaw chuck, complete with the strip, and tighten lightly, adjust the position of the jaws so that the table is in as balanced a position as possible. Rotate the table to see that the front face is running reasonably true. Gently tap the face of the table as appropriate until the table runs true, then tighten the chuck very firmly.

First check that the face still runs true and if OK give the table a very firm pull to determine that it is firmly held. At this stage machine the face as shown in **photo 17**, this photograph is simulated as the original photo was spoilt, so it shows the table fully machined.

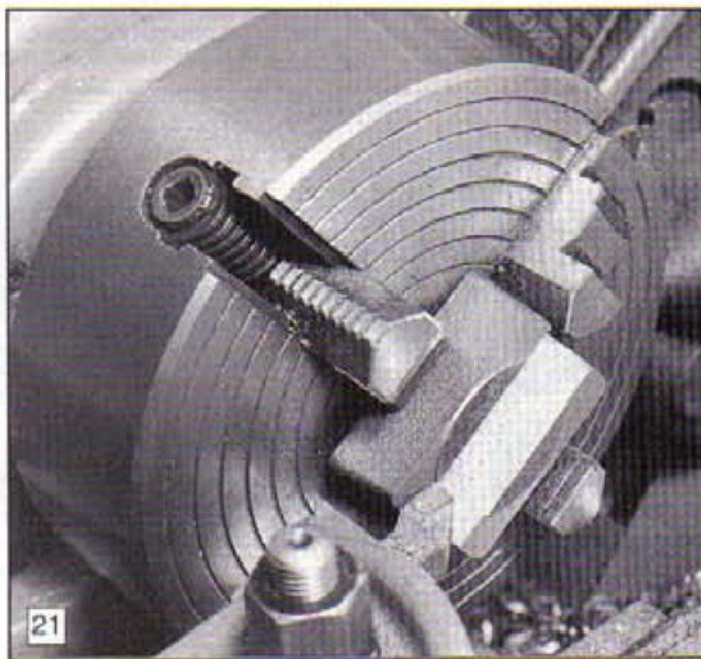
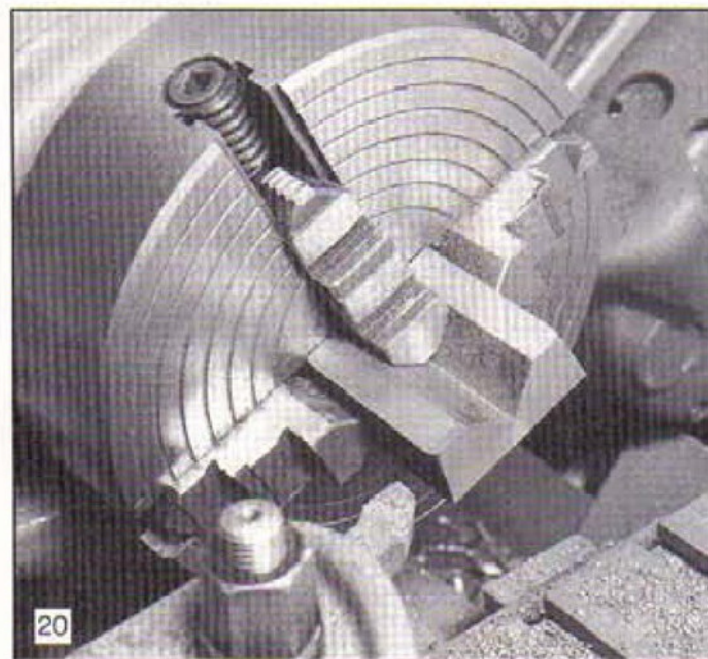
When removing the table from the chuck it will be found that the soft metal strip has been indented, ensuring the casting had been gripped over a distance, rather than just by the tips of the jaws. This procedure worked well on the one made and there was never any sign that the table was insufficiently held. Whenever attempting to grip irregular objects in a vice or a chuck the inclusion of soft copper or aluminium pads will always improve the hold by increasing the area gripped.

Turn the vertical slide so its face is again along the axis of the lathe. Mount the table onto the slide as seen in **photo 18** and drill and bore as shown. When positioning the table, place a small engineers square on the lathe cross slide and against the machined edge of the table, this will ensure that the hole will eventually be at right angles and/or parallel to the slots and edges.

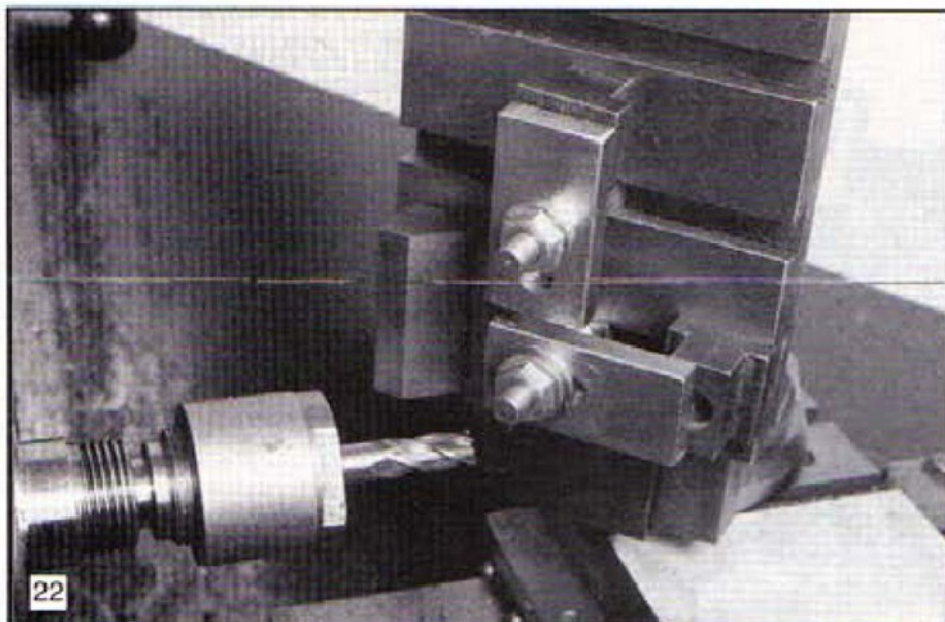
Drilling a hole $\frac{1}{8}$ in. dia. requires a lot of pressure, even if a pilot is drilled first, so place additional supports at the rear of the casting as seen in the photograph. Bore out to $\frac{1}{8}$ in. diameter using a boring tool mounted in the four jaw chuck. Use the four jaw chuck to make adjustments to the diameter and therefore achieve an accurate dimension to the hole.

For the photographically minded reader, the camera was set too fast for a flash picture and the left hand side of the print was almost black, hence the absence of the chuck in the picture. This was also the situation with the previously mentioned failure.

Return the vertical slide to the position at right angles to the lathe axis, setting this up accurately with the use of a dial indicator. Do not rely on the slide's angular calibrations, even if this is what you have done up to this point. Mount the table as in **photo 19**.



20/21: The six faces of the vee for both vee blocks are machined while mounted in the four jaw chuck.



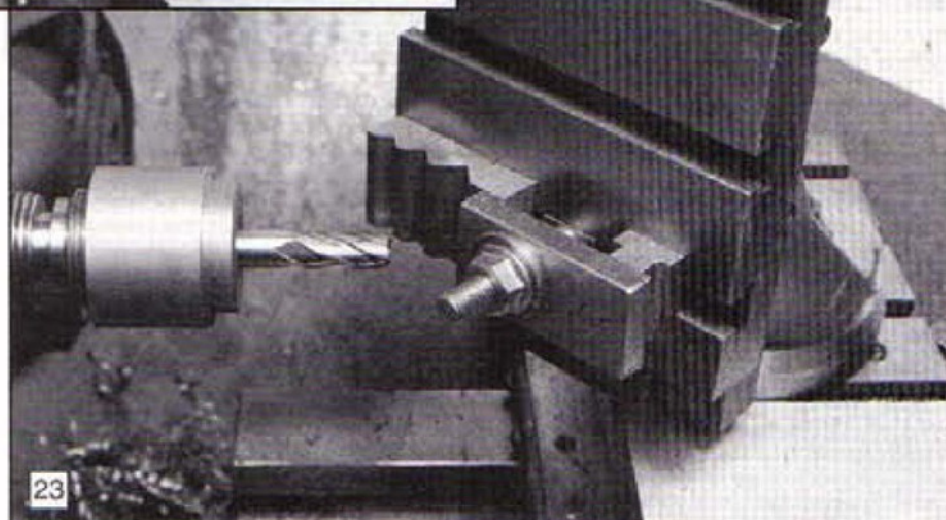
22/23: Machining the vee grooves with the slide set at 45 degrees.

Whilst accuracy of alignment is not that important, the strip of steel placed in the lower tee slot helps the table to stay in position whilst it is being clamped. Now machine the back of the table as shown, the thickness of the table is not important, but it does need to be the same thickness all over, hence the requirement for the accurate positioning of the slide.

Vee blocks

There remains two small castings to machine, namely the vee blocks, the larger having a single vee and the smaller three small vees. Each block requires all six sides to be machined and these are done whilst mounted in the four jaw chuck, typically as in **photos 20 and 21**. The blocks are likely to be shallower than the chuck jaws and so, for some faces, parallels will have to be slipped between the face of the chuck and rear face of the block before the chuck is tightened. Safety hint: the parallels **MUST** be removed before the lathe is started.

On completion of machining the sides, once more return the vertical slide to the



lathe, this time setting it at 45 degrees. Mount the vee block on the slide face and clamp lightly, then, using a small engineers square off the side of the slide to accurately position the vee block, tighten the clamps fully. Machine the vees as shown in **photos 22 and 23**. As seen in photo 1 the blocks come with vees already cast in and

QUICK TIP

The tungsten carbide tipped sawblade (woodcutting) that suits my Makita circular saw can be replaced cheaper than having it re-sharpened, approximately \$48.00.

By unsoldering the tips from the worn out blade and re-brazing or silver soldering them onto the ends of pieces of 6mm square mild steel, then shaping to suit on a silicon carbide wheel, results in beautiful little lathe tools for my Hobbymat MD 65, and cheap tool! There are about 25 tungsten carbide tips per old saw blade.

Peter Bowes

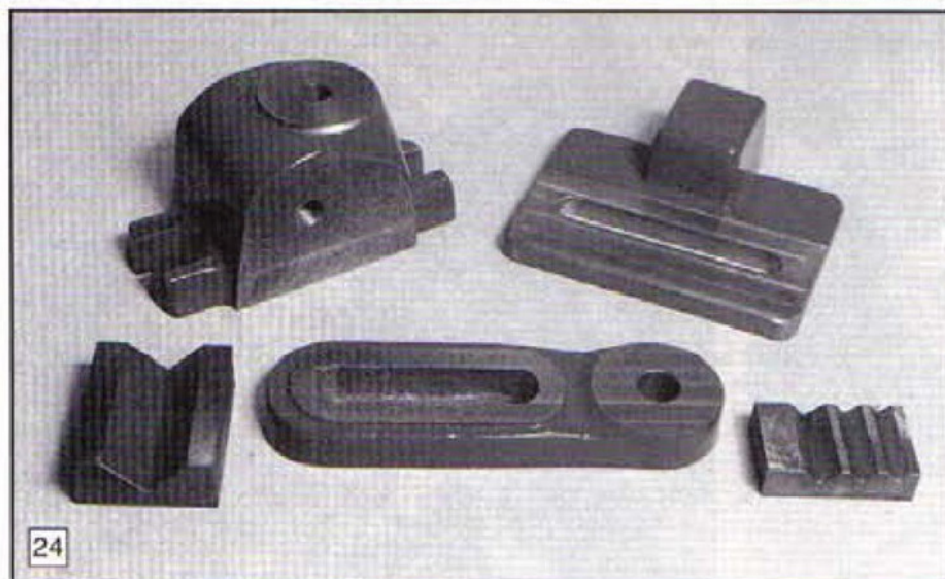
these are quite clean, readers who are very short of time may choose just to clean up with a file. Complete the vee blocks with the addition of the single fixing hole in each one.

Finishing the castings

With the machining of the castings complete, remove all sharp edges with a fine file and where appropriate, such as the vee blocks and the table top, make this a chamfer of about $\frac{1}{16}$ in. It is well worth cleaning up the non machined surfaces of the castings and applying a coat of paint for appearance and protection. If done to exhibition standards this can be a time consuming operation, but a rub over with a file to take off the high spots and a coat or two of quick drying paint will not take long. The very small tins of paint made by Humbrol, and obtainable from model shops, are very useful for this application. **Photograph 24** shows the finished result, it is worth comparing this with the first photograph in the article.

Other parts

I will not detail the method for making the remaining parts; the majority of the work is quite straightforward. However, there are a number of points that are worth mentioning, these will be dealt with in Part 2, in the next issue.



24: The castings fully machined and painted.

PLAIN MAN'S GUIDE TO MATERIALS - NON FERROUS

Mr Loader continues his plain man's guide to materials with some valuable information on non ferrous metals.

Most of the non-ferrous metals we use are based on copper and aluminium, copper is the most popular.

Copper

In its commercially pure state, copper is quite a strong metal with many virtues. It works easily, hot and cold, and can be joined easily by soldering, silver soldering and riveting. Its malleability and ductility can be judged from the very thin foil and wire it can be made into. It touches everybody's life somewhere and the plumbing and electrical/electronic trades would be in trouble without it. Combining its good heat conduction with ease of joining and a good resistance to corrosion by water, makes it ideal for boilers, pipe work and components for engines, model and full-size. Add to this a very good electrical conductivity and it does very well for things like soldering iron bits.

It does have some drawbacks. When it has been cold worked for a while, like bending or hammering, it work-hardens and can crack or split. It can though be softened by heating to dull red and leaving to cool or quenching in water. Unlike the ferrous metals, water quenching from red heat doesn't harden, the opposite in fact. As with other metals which work-harden, if there is any doubt soften before doing any work. This applies especially to rivets, they always need to be dead soft to begin with.

Turning copper isn't too difficult but a pointed tool can tend to tear the metal and leave a grotty finish, so a stoned or ground radius will help. It also conducts heat very well and will get very hot with large cuts and heavy feeds; plenty of coolant will wash the heat away and stop the tool tearing. If, like me, you are lucky enough to work indoors, the coolant will be a non starter, so be patient and use lighter cuts and feeds. Treat it like mild steel and use a rake angle of 20 degrees and similar cutting speeds.

Drilling and reaming too can be done as for mild steel, plenty of lubrication for the reaming. The fun begins when there is some tapping to do, especially in the smaller sized threads. This is because the copper, being very ductile, will try to flow with the pressure rather than cut. It makes the tap stick and sticky taps break easily. I've used the word 'sticky' to describe the feeling through the tap. If the tapping drill size is increased by about 5% of the thread

PART 2

diameter, it helps. So does a sensible tap wrench, too small is better than too large. More taps are broken by too much leverage than any other cause and a broken tap is very difficult to get out of copper. Lots of lubrication helps when tapping.

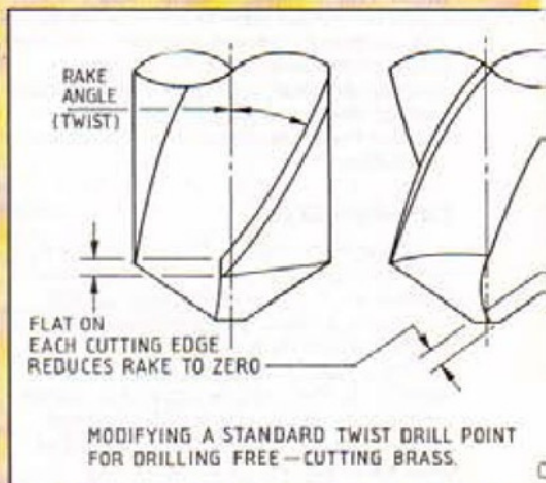
All this grief can be avoided by using a cold forming tap or a spiral fluted one. Cold forming taps are excellent for any of the very ductile metals, they have no flutes and work like a self-tapping screw. They need lubrication even more than ordinary taps, oil or vaseline does a good job if nothing else is to hand.

Like a lot of other metals, copper can be even more useful when alloyed with others. The brasses and bronzes are the most important of these and there are many jobs which would be poorer without them.

Free-cutting Brass

This does exactly what its name suggests, machines and cuts beautiful. It is made from 58% copper, 39% zinc and 3% lead. The lead is there to improve the machining properties. If you are lucky enough to buy from a supplier who knows his brasses, the number is C.Z.121. It is a pale straw colour and is quite brittle. It won't bend much and it isn't any good trying to bend it hot because that won't work either; it may bend slightly but severe working, hot or cold, is out. It is as a machining metal that it comes into its own and it is a pleasure to turn or mill. Turn it with a rake angle of 0 deg. and cutting speeds of 300 ft./min. or more, good finishes and accuracy are easier than most metals. Even tool grinding is easy with the clearances the only angles to bother about. It will shower the machinist with small chips, so eye protection is a must. Because no coolant is used there is no hindrance to flying particles and a close-buttoned collar is a good idea, the chips come off very hot and will find their way into any collar gap.

Drilling can be a problem in sizes over 1/4 in. Standard twist drills have a built-in rake angle of 20 deg. or so. This makes them unsuitable for drilling free-cutting brass. When the drill breaks through, the work tries to climb up the drill and even in the smaller sizes there is a kick which can be felt through the drilling machine handle. It can be very dangerous and I have 40-year-old scars to prove it. To avoid trouble the drill point needs modifying as shown in the sketch, so that the cutting lips have a zero rake or even a slightly negative one. This is done by grinding small flats on each cutting edge. 1/16 in. is enough for most sizes



and for the smaller drills the flats can be stoned. Keeping them small is important because the drill has to be re-ground for normal use and each re-grinding shortens it.

An apprentice memory

Recognising the hazards in drilling free-cutting brass came to me early in my apprenticeship when I had to drill 4 blocks of brass with a 1/4 in. hole. The blocks were about 1/2 in. thick and probably 3 in. by 2 1/2 in. I say probably because it was a long time ago and I'm relying on a vague picture in my mind. The stores issued the blocks and I took them in good faith as being the same material all through. To a storeman one piece of brass is the same as another and there was no specification mentioned on the drawing. The drilling machine I was using was a gear driven one; they are fine till something goes wrong. On a belt driven machine the belt will slip when there is an unforeseen occurrence, on a gear driven one you've had it.

All went well with the first two blocks but the third one shot up the drill and in no time everything was going round, job, vice, the lot. I hadn't clamped the vice down or even put a stop pin in to stop it spinning. I learned several valuable lessons. Firstly, there were brasses with very different cutting characteristics, also any job to be drilled over 1/4 in. really needs clamping. Finally, if mistakes are to be made, they need to be little ones to escape the eyes and ears of apprentice masters. As well as several cuts streaming blood, I got a severe rocket. A vice hitting the floor after several other things en route makes a fair bit of noise, so I got the customary cat calls and comments from the spectators as well.

On the credit side, free-cutting brass taps and reams like a dream. When hacksawing or filing, use a newish blade or file, worn ones will skid over the surface and not grip.

the same as they will on cast iron.

It solders and silver solders very well but be careful when silver soldering because the melting temperature of the brass isn't much higher than some grades of solder, another useful fact I found out at about the same time as the drilling incident. I had to separate and then re-join a component made from two parts and silver soldered together. Apprentices always use too much heat and being no exception, I overheated it, plastered it with flux and welded it securely. No amount of force would separate the two parts. After I'd had a telling off, my apprentice master explained what I'd done and told me to make the whole lot again. I think that was when he told me that, if I worked very hard and took notice of everything he told me, I might one day make fourth engineer on a Chinese junk. Brazing any sort of brass is difficult because the brass is likely to melt before the spelter.

Cartridge Brass

This was the metal which the first two blocks I drilled without any problems were made from. It is quite different from the free-cutting. The colour is yellow and it is tough and ductile. As the name tells it is used to make cartridge cases and any metal to do that must be capable of severe working. Its official title is C.Z.106, it has 70% copper and 30% zinc and bends and cold works easily.

It can be treated like mild steel for all machining and drilling operations and needs no modification of the drill cutting edges. Like the free-cutting, it joins easily by soft and silver soldering and it makes good rivets. From time to time my wife needs a handbag strap shortened or changed for some reason and the favourite metal for the hollow rivet which holds the pieces together is cartridge brass.

Tube of all sorts is made from this metal, I remember in particular some thin walled tube called Rollet tube of which each larger or smaller size fitted into the next size. Rectangular tube for waveguides used in radar installations for channeling the radar waves is also made from cartridge brass. It can be drawn into thin wire and rolled into thin shim. The photograph shows two very

different products: the gear is machined from free-cutting, the wood screw and the other screw are made from cartridge by cold rolling and forming, operations which need quite different properties.

There are more types of brass, of course, too many for the scope of this article, but I've dealt with the two we use most. Remember, if you ask a shop or supplier for 'brass' that is just what you'll get, whichever comes to hand first, and you too could have problems drilling it.

Bronzes

Bronze is a very ancient metal dating to before 2,000 BC, another part of the magic of materials - the age of some of them. I wonder who first found out that if a little tin was mixed with copper, a very much stronger metal could be made. Was it accident or design? Was it the sword maker or the jeweller? Was it dramatic enough for the discoverer to be thought of as a magician? Whoever it was, we are in their debt for finding us another useful metal.

Casting Bronze

An excellent casting metal used for all sorts of small to medium sized parts. A typical composition is 89.5% copper, 10% tin and 0.5% phosphorous, the reference is 1400/PB1-C, for the record, and it is one of several sorts used for leadscrew nuts, gears, wormwheels and bearing brushes. It has very good bearing properties when used against steel and has many applications in engines and mechanisms. Like copper, it resists corrosion very well and it has a good strength. The colour is straw and it has a scaly outer skin. The more tin in it, the paler the colour.

Like most cast metals it is brittle in some respects, but it machines well with broken small chips with an exception which I'll come to shortly. For turning, a rake of 8-10 deg. and feeds and speeds as for mild steel will suit it. It needs a sharp tool and, as with

other cast metals, the first cut must get well under the scale. It gets very hot when machined, so it needs cooling for heavy cutting. When using a plug gauge to gauge a hole it has a habit of seizing the gauge if the work hasn't been allowed to cool. I can vouch for the difficulty of moving it. Like free-cutting brass and cast iron, it needs sharp files and hacksaw blades to avoid skidding. Tapping and reaming is no problem but for drilling holes over 1/4 in. the job should be clamped and the drill kept cool. Scraping is easy, just as well because some large bearings need scraping to bed them in.

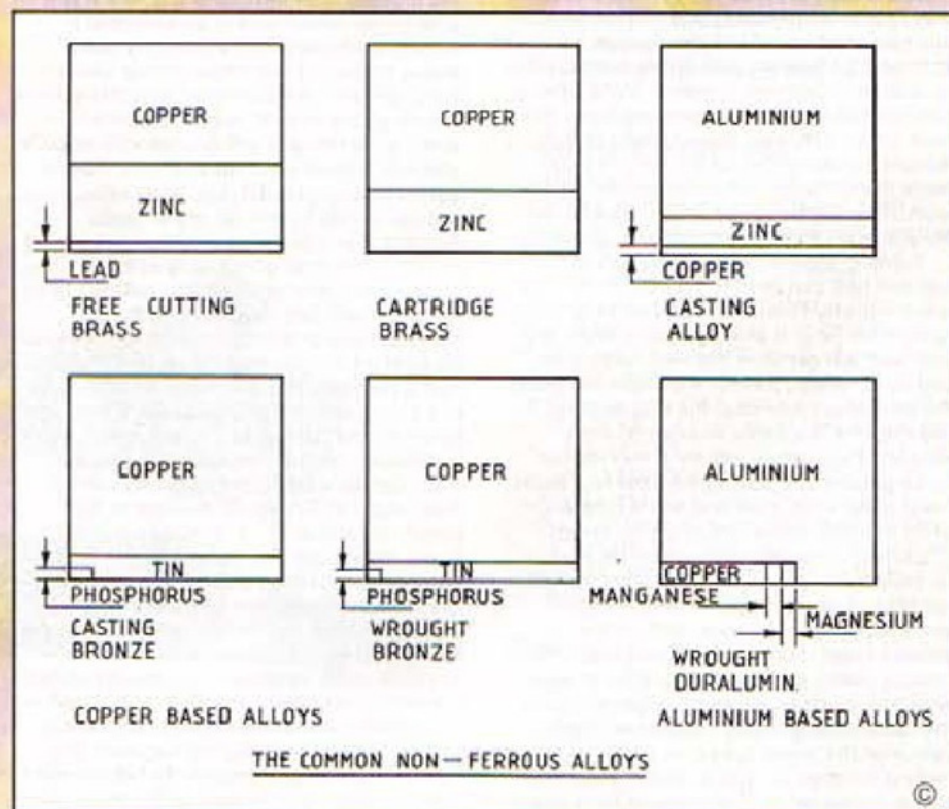
When I was an apprentice, one of the regular jobs on the turning section was making gear blanks from bronze. The stores had supplies of two different sorts of cast bronze bar. One was ordinary gravity cast and notorious for blow-holes which were very often down the centre of the bar. As we had to bore the blanks accurately (reaming was not allowed) this caused many problems and a chorus of 'my word how unfortunate'. Gravity cast stuff was easy to spot, there was a part line down each side of the bar. The other sort had no part line and we were always glad to see it because it had no blow-holes either. It was called spuncast and had been centrifugally cast by pouring the molten metal into a spinning mould. This throws the impurities to the outside of the bar and eliminates the blow-holes.

Wrought Bronze

This has a different composition from the cast and the colour is much more coppery. It has less tin and phosphorous and a typical one would have 96% copper, 3.75% tin and 0.1% phosphorous, its reference is 2870/PB101, and I know that the figures don't add up to 100%, but I have quoted them accurately. Wrought bronze is a good metal for small gears, bearings, lead screw nuts and the small components which can be made from bar stock. Like



Different brases. The gear from free-cutting, the screws from cartridge brass.



other wrought metals, it has been made by rolling from the ingot and finished by rolling, drawing or extruding. The final process is done cold, which in the case of bronze, gives it a springy quality, especially in strip and wire. The springiness is useful for making springs which have to be non-magnetic and reasonably corrosion resistant.

It machines very much like the cast variety but the swarf will be longer and pile up and wrap round things. Swarf will have savage cutting edges, **so use pliers to remove it.** It also gets very hot, so use coolant or leave occasionally to cool off. Drill and ream as for mild steel but drill a little big when tapping, there will be the same sticky feel as with copper. Filing and sawing is easier than with the cast variety but it doesn't scrape quite as well as cast; most wrought metals are not such good scraping metals as cast.

Gun Metal

I know that some people refer to any sort of bronze as gun metal but it isn't. Gun metal is a different alloy with zinc in it and no phosphorous (the phosphorous is only in cast and wrought bronze as a flux to clean the metal). It is used to make pump and valve parts where corrosion resistance is a major requirement. The name gun metal is a much abused one used by some novelists and womens' fashion designers to describe a grey colour; they should know better, because the colour is very much like free-cutting brass. If you ever have to work with *genuine* gun metal, treat it like cast bronze, you won't go far wrong.

There is another way of using bronze which applies especially to bearings. This is sintered bronze, made by a similar process to the carbide tips. The bronze is powdered, mixed with a binder and some wax, then compressed and heated in a mould shaped for whatever the finished shape will be. The wax melts out, leaving small voids in a solid shaped piece of porous bronze. It has the metal's bearing properties and the ability to hold lubricant in the voids. It can also be pre-lubricated, as in Oilite bearings and the bearing can often be a very thin shell, saving on the cost of the material. It is used a lot for the pads in both travelling and fixed steadies which bear on the work to support it. It is not the sort of metal we normally machine, but it will cut if necessary. It is a very crumbly metal and will chip out at the end of a cut, so use dead sharp tools and be careful.

Aluminium

Compared with the antiquity of bronze, aluminium is a newcomer. It wasn't around much before the early 1800s and the extraction process is electrical, needing large supplies of cheap electricity to make it worthwhile. It illustrates the link between the availability of metals and the fuel technology of the time. Copper, for instance, needs a temperature of 900 deg. C. plus to melt it, within the scope of the charcoal which the bronze age metallurgists had. Steel, needing 1200-1500 deg. C. had to wait for coke. Aluminium had to wait till there was lots of electricity at a reasonably low price. When the metal was new enough to be a novelty, it was the done thing at some state banquets for the top people to eat off aluminium plates, while the *hoi-polloi* had to be content with mundane silver!!

Two factors influenced the rise of aluminium as an engineering metal, the expansion of the electrical supply industry and the first experiments with airships. The one needed large amounts of very light metals, the other was the means of production of the metal. The difference between the cost of aluminium in 1855 and 1906 showed a reduction of about 500 fold.

The main virtue of the metal is its light weight, about 1/3rd that of steel. It is silvery-white, soft, ductile and malleable, very corrosion resistant and a good conductor of heat and electricity. In the pure state it is used a lot in the food industry, for packing and containers. Foil is a good example of its malleability, the foil used for cooking is usually 0.001in. thick, very useful when a thin shim is needed. It also shows the softness; it will crumple into a ball easily with hand pressure, steel of the same thickness would be far more difficult. Aluminium isn't easy to join by thermal methods, there are welding and brazing techniques, but they use equipment not readily available to the amateur. The main reason for the difficulty is that the metal oxidises very quickly in air and the oxide isn't easy to displace. It can be soft soldered with special solders but it isn't easy. I once watched a colleague using ordinary soft solder to tin a piece of aluminium sheet, that didn't look easy either and I remember that a wire brush had to be used to get the solder to wet the sheet.

As it is a soft and weak metal in the pure state, it needs the magic touch of the metallurgist to make it stronger and harder by adding small amounts of other metals. With its low melting temperature it is a good casting metal for both gravity and die casting. Die casting can make very accurate and detailed castings which need little finish machining. Look under the bonnet of a car, or into the innards of a washing machine, and you will see plenty of aluminium castings. Modern lathes and other machines will have some parts cast in aluminium, the tailstock, headstock and cross slide of my Unimat are typical examples.

The low melting temperature can be a mixed blessing in some circumstances. I once broke a 4BA tap in an aluminium casting. It refused to budge, so the only option was to soften it, drill it out and re-tap. Luckily, it was made from carbon tool steel and would soften, but by the time it was red hot, the surface of the casting was beginning to bubble round the hole. I was using the smallest flame I could but it needed a lot of prettying up to get it

through the inspection.

One use for the metal in the soft state is rivets. It must take the first prize for riveting, lovely and soft and a pleasure to use. There is more to model engineering than riveting though, and like other alloys, there are many different ones based on the pure metal. Those we use most are the casting ones and the wrought ones.

Cast Aluminium Alloys

In a typical casting alloy there will be some zinc, copper and silicon. The zinc lowers the melting temperature, the copper strengthens and the silicon helps the casting process by making the metal very fluid. Silicon is in most aluminiums and there can be up to 12% in some castings. Unfortunately it has an abrasive effect on the tools, so cutting edges need looking at frequently and keeping sharp. The recommended rake for aluminium and its alloys is up to 40 deg.; take no notice when machining the castings, 15-20 deg. is quite enough. The rule is, soft and ductile metals, large rake; hard and brittle ones, low rake. Although aluminium is a soft metal, the castings are brittle.

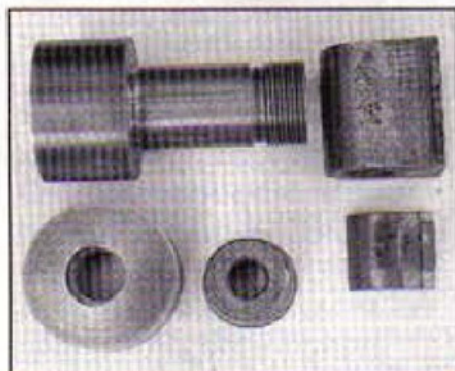
As with all castings, get under the surface scale with the first cut. Cut dry if possible because the swarf is very bitty and it will mix with coolant to make a horrible sludge which gets everywhere. Like other brittle materials, the edges will chip and crumble under large cuts and heavy feeds, so do the same as for cast iron and set the tool obliquely or ease off at the edge of the cut. Be very careful when clamping and holding aluminium castings, especially in thin sections, because you have low strength as well as brittleness to contend with. Drilling, tapping and reaming is no problem and paraffin makes an ideal lubricant.

Wrought Aluminium Alloys

The wrought ones are usually good machining metals. Some of the softer ones can be a bit of a pest when the swarf builds up and wraps round things and there can be a problem with a phenomenon called 'built up edge'. This is caused by minute particles of the metal welding to the cutting edge of the cutter as they pass over it. Pressure does most of the damage. In time the edge becomes masked by a shield of aluminium sticking to the edge and getting thicker till the pressure breaks it off. The cycle begins again, and the finish is spoilt because of the intermittent cutting. There is more than one cause of this problem but the most effective remedy is to use plenty of lubrication where it matters, on the cutting edge.

It isn't always easy to spot the softer alloys by appearance, so another way of sorting them out is to tap them with a piece of steel. A ringing noise means that the metal is reasonably hard. The less musical the metal, the softer it will be. With the soft ones, treat them like copper when tapping and use plenty of lubricant while machining. Cutting speeds can be anything between 200 and 300 ft./min. depending on the conditions. A rake angle of 30 deg. will be enough.

The reason why wrought alloys are more useful than the pure metal, is because of the other metals mixed in and the production processes of rolling, drawing or extruding which gives them extra strength and hardness. One of the most useful is duralumin.



Bronzes: on the right, castings. Centre, a sintered bush. On the left components from wrought bronze.



Two aluminium castings and a selection of small parts from duralumin.

Duralumin

As it was originally developed for the aircraft industry, it is appropriate that model engineering, follows full-sized practice, and uses duralumin for making model aircraft engines and similar projects. It is made by adding 4% copper, 0.5% manganese and 0.5% magnesium to aluminium. These additions wave the magic wand again, and the result is a metal as strong as some steels at 1/3rd of the weight. Not only that, it has the useful property of age-hardening. It reaches maximum hardness just by being left at room temperature for 5 days. It can be softened quite easily, but if left, will harden up again after the 5 days.

Softening is done by heating to 375 deg. C and cooling. It doesn't seem to matter whether it is quenched or left to cool on its own. The snag is to judge the 375 deg. C, which is out of the range of the gas oven. A mis-judgement could result in a pool of molten metal.

There are two ways of getting the temperature right. One is to heat the metal till a matchstick or sliver of wood just chars when touched to it. I can't vouch for this method because I've never used it. I prefer to use the soap method. The part to be softened is coated with soap by going through the motions of washing, getting the hands well soaped, and then thoroughly smearing the metal. It is then heated till the soap turns black, and cooled; when cold it will be soft enough to do anything within reason, like bending, twisting or riveting. Don't forget that it will re-harden in the 5 days. If for some reason the hardening must be delayed, put it in the freezer. If your freezer runs between -7 and -10 deg. C it will stay soft till taken out.

I can recommend the soap method because I've used it a lot. When fishing was my main interest years ago, I made a landing net frame using duralumin bolts for the corners. The metal softened very easily and stood up to some severe bending, especially where I bent one end into a completely closed eye where it fits over the thread which fastens it to the handle. The frame served me well for many years before fishing lost its appeal, due to crowds, portable bivouacs and transistor radios. I still have it, 30 odd years on and it is still in good order.

Duralumin is a marvellously good tempered metal to machine, it will give accuracy and excellent finishes under most conditions. Speeds can be cranked right up and with good cooling and sharp tools, cuts can be heavy and feeds coarse while roughing. Finishing cuts with a freshly ground tool are a pleasure. Rake angles

can be between 25 and 30 deg., although sometimes, when I've been too idle to change the tool, I've turned it with no rake at all with no ill effects and no different finish.

Drilling, reaming and tapping are no trouble with paraffin or lubricating oil to help things along. It hacksaws and files very well and doesn't pin like some of the softer alloys. For ease of working, accuracy and finish, I have always enjoyed using it.

One final caution, when marking it out, use a pencil or spirit marker rather than a scribe. Scribed lines have a tendency to become cracks, especially on bends.

Aluminium and its alloys can be protected from corrosion by a process similar to electro-plating called anodising, a process which gives the same sort of protection as silver, cadmium or nickel plating on other metals. *(The coating is however electrically non-conducting. Ed.)*

Of the other non-ferrous metals we use, most are used as alloys and rarely on their own.

Tin

Tin is used in some alloys and for coating copper wire for electrical work, thin steel sheet for food cans, and many other coatings where corrosion resistance and electrical conductivity is important. Cans for food, oil, drinks and other contents are made from quite thin steel, thin enough to be cut with good scissors, *not* your wife's dress-making ones, *nor* her kitchen ones, but the pair you have, of course, bought especially for your own use. This tin plate is very easy to solder and makes good fuel tanks for model aircraft, provided that the right side is used; most food cans are coated on the inside. I made several tanks when my son was a model aircraft enthusiast and it was quite easy, the seams can be soldered with a modest size of soldering iron. I used a 125 Watt one with a 1/16in. copper bit.

Another use for empty 'tin' cans is for shims and packers, the thickness is often just right for the last little bit to bring the tool on centre, for example. The thickness varies from 0.005in. to 0.009in. and possibly thicker for some of the really big ones. I keep a few pieces handy, but remember that the edges left by scissors are razor sharp, so de-burr the shims thoroughly.

Tin has a very low melting point and is mixed with lead to make soft solder. The more tin in it, the quicker it sets, because tin goes from liquid to solid very quickly. In a high quality solder, there will be as much as 65% tin. It is also one of the ingredients of bronze, as I mentioned previously.

Lead

Apart from its use in solder, lead is used in some metals to improve the machining qualities, free-cutting brass and leaded steel are two examples. The percentages are small, about 3% or less and you'd think that if it made other metals easier to machine, it would be easy to machine itself. It isn't. It is difficult to hold without making marks, it cuts very stringy and clogs tools. Drilling is the worst thing to have to do, especially in the smaller sizes. A lower speed and candle wax for a cutting lubricant works as well as anything, it is a good job that lead doesn't have to be machined very often. With its low melting point it is easier to mould it. Going back to my fishing days, I used to make lead

weights in different shapes and sizes, from pierced bullets to 'coffins' and Arlesley bombs. I had various moulds made from brass and used to core the holes for the line to go through with 0.080in. stainless steel wire; it always knocked out when the lead was set.

Lead is useful for its weight and makes a good material for weighting the outboard wing of a control line model aircraft and probably has a use in the keel of model yachts. Another common use for a lump of lead is for hitting something hard without causing damage. A cylindrical shape moulded on to a handle makes an ideal soft hammer.

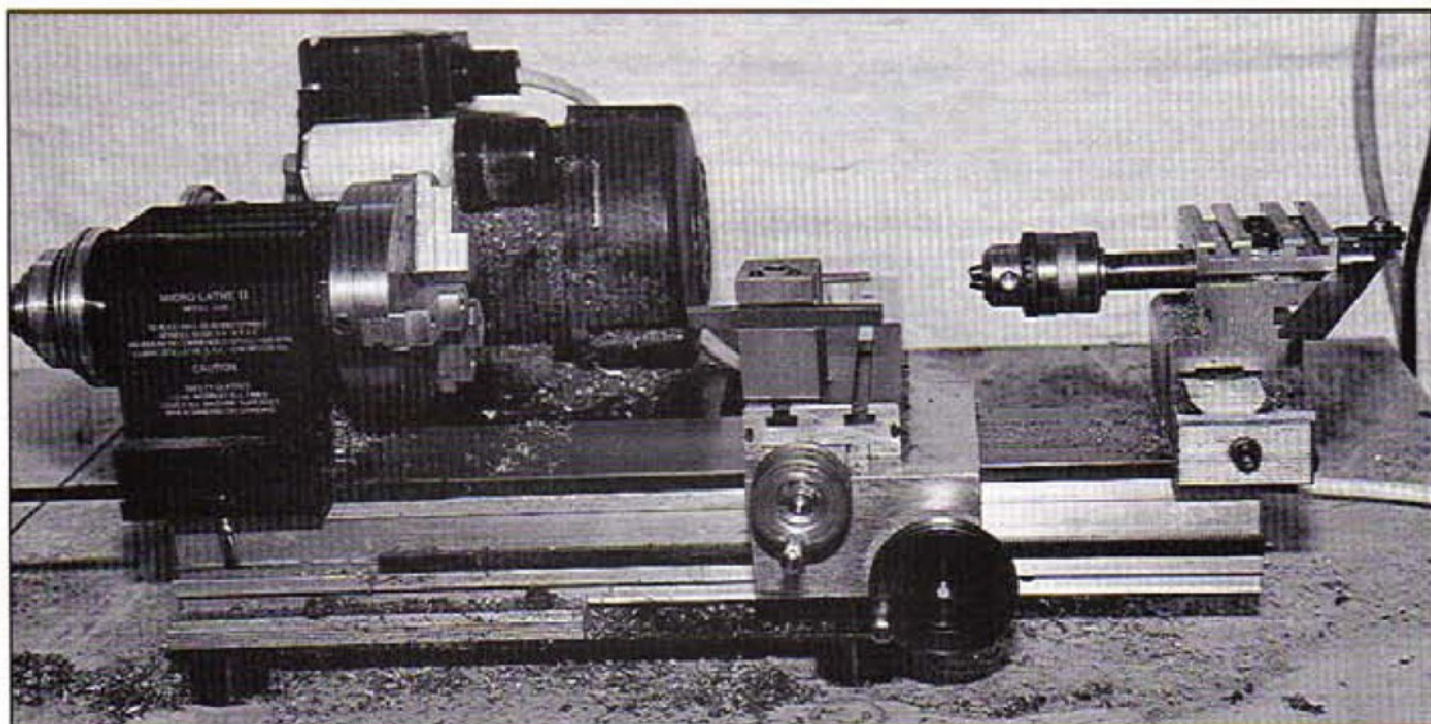
Zinc

As it is another of the low melting point metals, zinc is used as the main constituent in a lot of die-casting alloys like Mazak. If a casting is fairly light, a dull grey colour, has a wealth of surface details and a good finish it is odds on that it has been die-cast. It is a process for all sorts of things which have to be made in large numbers at low cost, from zip fastener elements to model cars and other bits and pieces like drill stands with the numbers cast into the surface. The compound slide of my Unimat, with the scale of degrees and the company logo cast in, is a die-casting. The method and material is sometimes used for things which could and should be made from stronger materials. These things break easily because of the brittleness of the metal and once broken, a die-casting is not easy to repair. Solder won't take, so it is a choice between Araldite, a mechanical joint like a riveted patch or, the best solution of the lot, make another one from stronger material. The trouble is, that the reason it was a die-casting in the first place, was the difficulty of making. Threads are one of the most aggravating things about die-castings, they strip out very easily, as model aircraft enthusiasts will find with some of the engine parts. Owners of small motor cycles and mopeds will have the same trouble with the sparking plug threads. It is sometimes possible to put in a plug and re-thread. If this isn't feasible, get to know someone who works for a company which uses Helicoil thread inserts, and talk nicely to him.

Die-castings machine easily at 250-350 ft./min. with a rake angle of about 10 degrees. Be careful when clamping because the softness which allows easy machining also allows distortion or marking, when holding in a chuck or vice.

Zinc isn't the sort of metal used much as a pure one. The last time I saw some was at my grandfather's about 30 years about. He had an old fashioned food safe, the sides were covered with perforated zinc. As far as I can remember, that's the only time I've seen it except for the few scraps which were always put into containers of killed spirits used for soldering flux. The zinc was put in with the hydrochloric acid until the reaction was complete, making zinc chloride, the scraps of extra zinc were to make sure that the spirits were indeed 'killed'. It is a similar flux to Bakers fluid.

I haven't mentioned every metal we use, it would need too much space and this is supposed to be a plain man's guide. So for further information on this fascinating subject, look in your local library and for useful summaries use the Oxford English Dictionary.



Side view of the Peatol lathe, showing 3-jaw chuck fitted, and Jacobs chuck attached to the tailstock.

A DIVIDING HEAD FOR THE PEATOL LATHE

PART 1

This rather nice dividing head, intended for use on the Peatol Micro Lathe, has been designed and made by Tony Jeffree. The Peatol lathe has not been featured greatly in *M.E.W.* and the article will, I am sure, be of great interest to owners of this lathe. The design in no way limits its use to this lathe; it would be equally at home on any other small, and not so small, lathe. Another interesting feature is that Tony's drawings were done using AutoSketch CAD software, see his letter page 8 of issue 17. This is one of the recommended packages in the article elsewhere in this issue. Tony's drawings are published as received, we have made no changes to them. The article will be in two parts.

When I decided to try my hand at clockmaking, I had not realised quite how much time would be involved in building a suitable set of tools before I started making any clock parts. Since then, it seems to me that the vast majority of the time spent in my model engineering activities has involved building tools or jigs of various kinds; often the one you are making at the moment is needed in order to be able to make the tool that will allow you to make the jig that will allow you to make the tool...etc. Eventually, you have the right equipment to make the part that you wanted in the first place. This article is the result of one such exercise, and one that has hopefully brought me closer to the final goal of building my first clock. The trouble is, building devices like the one described here can easily become an end in itself, so I may find that the goal will not get any closer; I am already working on the design of the Mark 2 version of this dividing head!

Clockmaking was also to be my first real skirmish into metal work of the model engineering variety. Previous familiarity with silversmithing had taught me the essentials of cutting and shaping metals using hand tools, but as I had no real experience of machining metal, and in particular, metal turning, the first essential purchase was a small lathe. After much poring over books on clockmaking techniques and equipment, I chose to buy the Peatol Micro Lathe. For those unfamiliar with it, the Peatol is a simple and inexpensive 2 1/4 in. centre height, plain lathe with a good range of accessories, including a vertical slide and compound top slide.

It comes as a partially assembled kit of parts, so the first exercise for the eager novice metal-turner is to assemble it, and in particular, to work out how to mount the various components on the base plate in a manner that will result in a usable machine... but I digress. The only real drawback with the Peatol is the absence of screwcutting facilities. Perhaps if there are any Peatol owners out there who have added screwcutting facilities to their lathe, they might enjoy telling the rest of us about it.

From my reading about clockmaking, I realised that gear cutting (wheel cutting, as it is known in the clockmaking literature) capability was important if I was to stand any chance of building a clock; so my first problem was to decide on a gearcutting method. A dedicated wheelcutting engine is often used by clockmakers; I discarded that approach on the grounds that such a device would be of little use for any other purpose.

The alternative of using a dividing head in conjunction with the lathe had the advantage that it would be useful for many other machining operations as well as for wheelcutting. As there is no dividing head in the Peatol range and all other designs that I had come across were too large to be conveniently used on a lathe of this size, I decided that I would design and build one myself. The usual comments apply, that although the design described was developed for the Peatol lathe, it could no doubt be adapted for use on other small lathes. In many cases the choice of materials reflects what I had to hand at the time I built the prototype; no doubt some readers will choose to use alternatives to suit the stock they have available.

Gearcutting set-up

There are two major options for a gearcutting set-up in the lathe. The first is to use the dividing head to position the lathe spindle, which in turn holds the wheel blank, and to employ a second driven spindle to drive the gear cutter. The second option is to use the lathe spindle to drive the gear cutter and use the dividing head, mounted on the lathe's vertical slide, to hold the wheel blank. As I was not in possession of a separate spindle to drive a cutter, this design was developed with the second configuration in mind; however, with the use of a suitable adaptor plate and split collet to attach the head to the lathe headstock and drive spindle, it should be possible to use the head in either configuration.

Design considerations

The Peatol lathe has Tee slotted cross and vertical slides, both 2in. wide by 3½in. long, with 2 Tee slots running lengthways ½in. in from each edge. Thus a dividing head that is designed to be mounted on the vertical slide can equally well be mounted on the cross slide. In the latter case, there is an advantage in allowing the dividing head to be mounted with its axis at lathe centre height, as this makes it possible to use the head to drill radial holes in a workpiece. This also requires that the mounting arrangements allow the dividing head to be mounted with its spindle axis at right angles to the lathe spindle.

A major consideration was provision of a chuck for work-holding. At around the time I started thinking about this project, I had taken delivery of a ½in. Jacobs chuck from Tracy Tools which came with a "free" 1MT arbor. With no facilities on the Peatol for the use of 1MT tooling, the arbor was redundant, but it led to the idea of using Jacobs chucks as the primary work-holding device for the dividing head. The prototype dividing head was built using this 1MT arbor, somewhat modified, as its output shaft. Set up between centres in the lathe, using the live centre in the tailstock, it was easy to turn the taper to a more appropriate profile. Needless to say, the arbor was not of the hardened variety! The construction of the main body of the dividing head needed to be simple, not least because of my as yet limited skills with using the tools of the trade.

Castings were ruled out on grounds of difficulty and expense should the design change as I built it. I had no technical drawing capability at the time; I intended to build the prototype without any formal design, as an exercise in familiarisation with machining techniques in the lathe, so design changes en route seemed highly likely! Since then I have acquired a CAD package, AutoSketch for Windows, which I would highly recommend to anyone who has a suitable PC and who doesn't want to learn technical drawing the hard way. The drawings in this article were generated using AutoSketch. In keeping with the general style of the Peatol, which makes considerable and ingenious use of aluminium extrusions in its construction, I chose aluminium angle and square sections as the basic constructional material for the frame of the dividing head and its fittings.

There seemed to be a considerable advantage to be gained by following

normal practice and employing a worm drive in the design of the head. The reduction ratio of the drive would in itself offer some useful division possibilities, in addition to those available by use of the division plates.

Dividing head theory

A dividing head generally consists of a 40:1 or 60:1 worm drive, with the input shaft driving the worm, and the worm wheel driving the output shaft. The output shaft is fitted with some suitable work-holding device for the item to be machined; the input shaft is fitted with an indexing arm, the position of which is measured either against a protractor or against a division plate (a disc with circles of evenly spaced holes drilled in it). Rotating the input shaft by a known number of degrees rotates the output shaft by a smaller amount, in the ratio of the worm drive. For example, if the drive ratio is 40:1, half a turn (180 deg.) of the input shaft rotates the output shaft by 4½ degrees. Alternatively, rotating the indexing arm by one hole position in a 36-hole circle (i.e. by 10 deg.) rotates the output shaft by exactly ¼ degree. A useful consequence of the use of such a reduction drive is that it improves the accuracy with which the output shaft is positioned, in the ratio of the drive. In the above examples an error of one degree in the positioning of the input shaft results in an error in the position of the output shaft of only ¼ degree.

If you wish to divide a circle into a given number of equal divisions, the number of rotations (or fractional rotations) of the input shaft necessary to produce a movement of one division in the output shaft is given by dividing the drive ratio by the number of divisions required. For example, with a 40:1 ratio, if you wish to cut a gear with 50 teeth, the input shaft must be rotated by 40/50 of a turn between each cut. This is where the numbered circles of holes on the input shaft come into play. The desired result is achieved by moving the indexing arm 40 hole positions on a 50 hole circle between each cut. (The same result can be achieved by, for example, 16 holes in a 20 hole circle, or 4 holes in a 5 hole circle, etc.)

My apologies to those readers for whom the above has been a lesson in egg-sucking; the point of all this is that it will be necessary later on to use the partially built dividing head, to mark out its own protractor, and drill its own division plates. A little thought up front as to how this would work told me that, once I had made an accurate protractor, I could produce reasonably accurate division plates simply by calculating the required rotation of the input shaft in degrees. I concluded that placing the input shaft for each division should be possible to better than a degree either way, so the error in the output shaft position would be very small.

In use, any error in the drilling of the division plates would again be reduced by the drive ratio, so if the first set of division plates were not accurate enough, I could always cut a second set of plates from the first, which would further improve their accuracy. If necessary, this process could be repeated until no improvement could be gained over the inherent inaccuracies in the dividing head and the drilling set-up. In order to follow this constructional route, I needed to choose a drive ratio that would

allow me to make a protractor using only the division capabilities provided by the drive ratio itself.

Choice of drive ratio

With a 60:1 worm drive, a 6-hole circle would be all that I would require in order to use the dividing head to mark out a protractor (6 times 60 being 360, so rotating the input shaft by one hole in the 6-hole circle gives one degree rotation of the output shaft). A 6-hole circle would be very easy to derive from a 60:1 ratio on the partially completed dividing head. One would simply mount a suitable blank on the output shaft, mount the dividing head on the cross-slide and use the lathe as a drilling machine; ten full turns of the input shaft after drilling each hole rotates the output shaft by ½ turn.

With a 40:1 ratio, a 9-hole circle would be needed. As there is no simple way of generating this from the 40:1 ratio, this was option was rapidly discarded.

A 30:1 drive plus a 12-hole circle would be a suitable, if unconventional, alternative to the 60:1 ratio; cutting the 12-hole circle requires 2½ turns of the input shaft per division. For the purists amongst us, a two-hole circle could be cut first, to ensure accurate positioning for the half-turns, but this really is unnecessary given the advantage in accuracy that is gained from the worm drive. In practice, I found that judging half-turn positioning by eye, by lining up the indexing arm against a handy vertical, was quite satisfactory for this operation.

30:1 was the final choice of drive ratio, partly as it promised to halve the number of turns of the input shaft when in operation (and hence offer a reduction in operator fatigue) and partly because a browse through the HPC Gears catalogue showed that there was a 30:1 worm drive in their 32DP range that seemed about the right size for the job.

Main components

Fig. 1 shows a side view of the assembled dividing head, Fig. 2 shows a rear view. The main components are:-

A main frame (Parts 3 & 4), fabricated from aluminium angle. One piece forms the base-plate (with holes for T-bolts) and the back plate; the other forms the top plate and front plate. The output shaft runs in bearings in the front and back plates.

The output shaft and wormwheel (Parts 5 & 6)

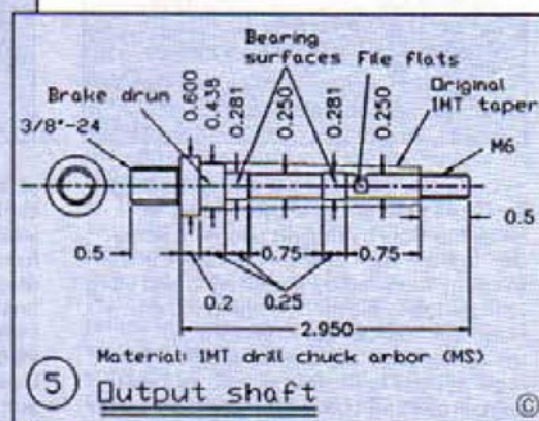
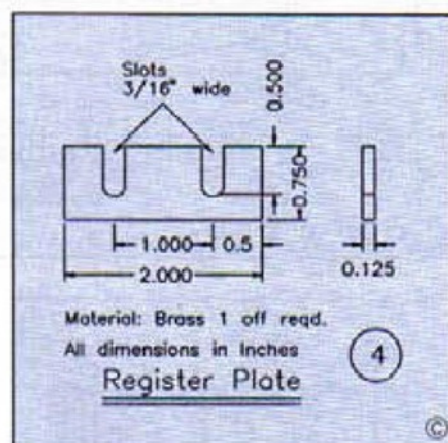
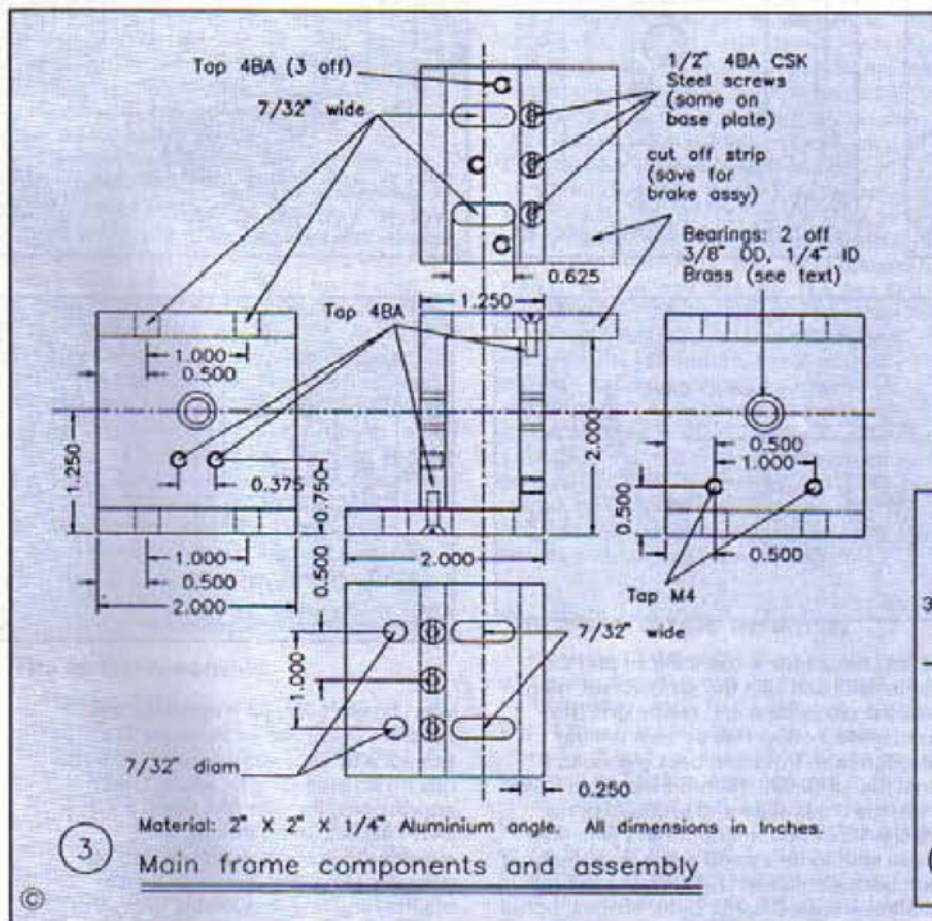
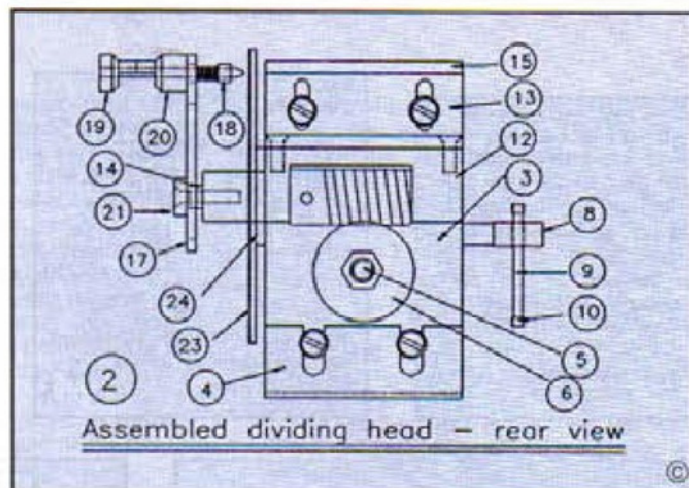
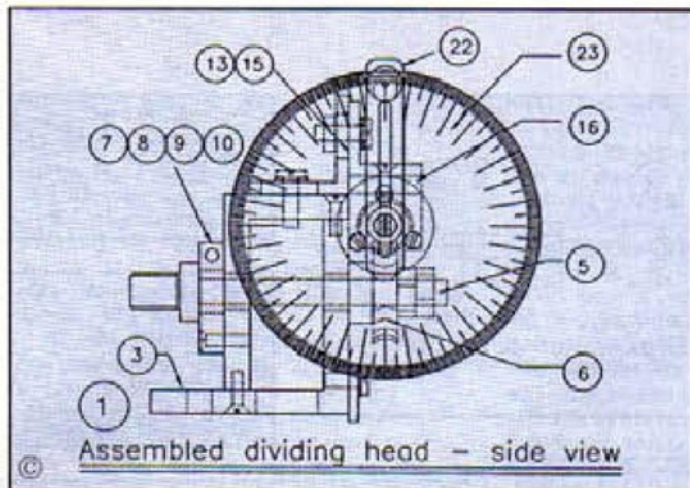
A brake assembly (Parts 7, 8, 9 & 10) (Assembly 11), to lock the output shaft.

A worm carrier (Part 12) (Complete assembly 16) fabricated from ½ in. square aluminium bar, mounted on the main frame by means of adjustable brackets (Parts 13 & 15) fabricated from aluminium angle. This adjustment allows correct positioning of the worm for minimum backlash, but could also be used to accommodate alternative wormwheel sizes if so desired.

The indexing arm/detent assembly (Parts 17 - 21) (Assembly 22) mounted on the input shaft (Part 14).

The protractor/division plate and carrier (Parts 23 & 24), mounted on the worm carrier.

A pair of sector arms (Parts 28 & 29) (Assembly 30), to simplify the otherwise hazardous process of counting holes in division plates.



An adaptor plate (Part 27) for added height when the dividing head is mounted on the vertical slide for wheelcutting or radial drilling operations.

A suitable construction sequence follows. Eagle-eyed readers may notice some detailed differences between the drawings and the photos of the prototype. The main changes are that the output shaft was originally slightly offset from the vertical line and the brake shoe was rotated by 90 deg. so the locking bar was vertical. The changes to the drawings have been introduced as improvements on the original design in the light of experience; in particular to make it easier to get to the front pair of T-bolts.

A final section of the article discusses some more major improvements that could be made to the design of the head, which the more adventurous reader may choose to experiment with. These are in the pipeline for a Mark 2 version of the head, which may, editor willing, form the basis of a future article once I have finished working

out the constructional details and developed a prototype. For Mark 2, I may even try a really radical approach and design it before I start the machining!

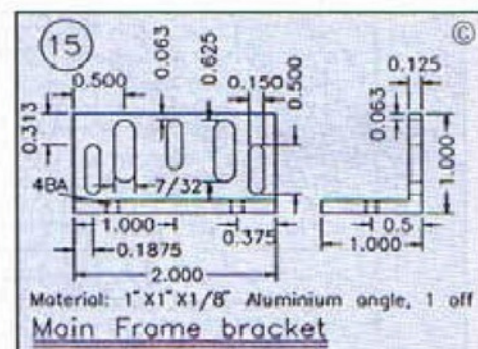
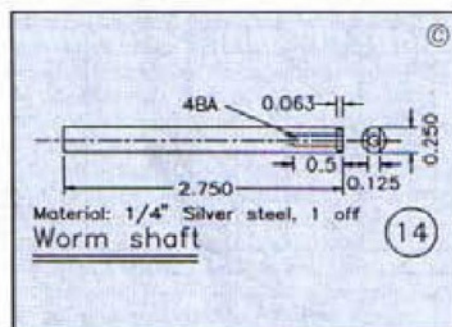
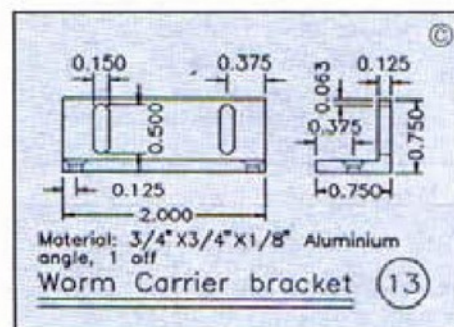
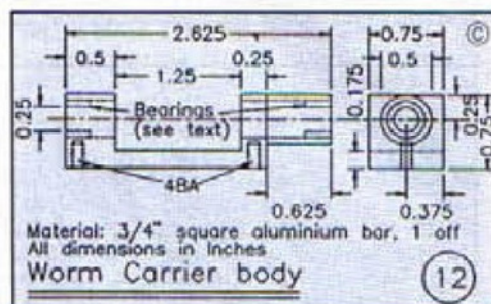
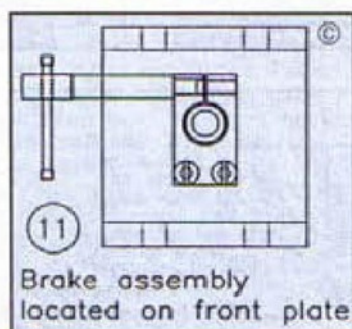
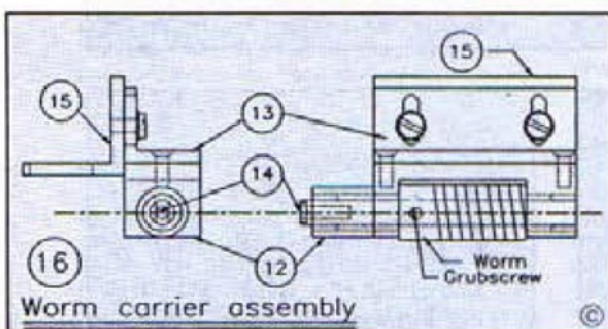
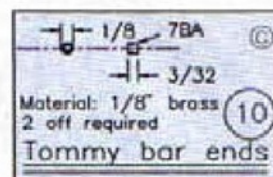
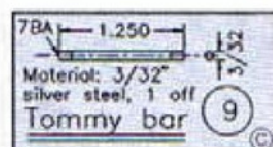
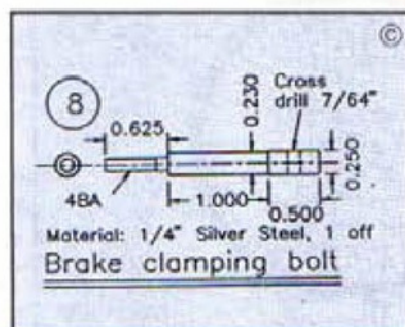
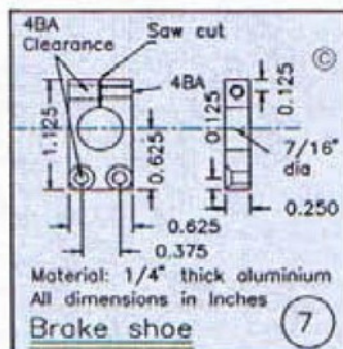
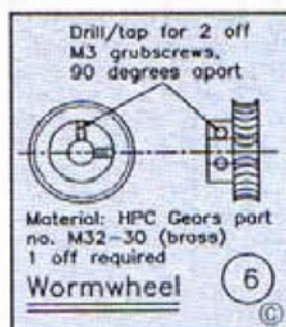
Constructing the main frame and register plate

The frame is constructed from two pieces of 2 x 2 x 1/4" aluminium angle as shown in Fig 3. Cut the lengths slightly oversize; do not finish to their final 2in. length yet. Cut off the excess 1/4in. strip from the piece that will form the front/top plate; with careful cutting the scrap will be usable for the brake assembly. Mark out, drill 4BA clearance and countersink the top and bottom plates for the six 4BA screws that will hold the two halves of the frame together. The countersinking must be deep enough for the screw heads to be sunk just below the surface. Clamp the two frame halves together in their assembled configuration. Spot through the holes to mark the positions of the holes in the ends

of the front and back plates, drill and tap them 4BA. Assemble the frame using 1/4in. countersunk steel screws. Finish the cut end of the top plate so that it is flush with the back plate.

Mount the frame in the four-jaw chuck, or on the faceplate and take a light facing cut to true up the sawn ends of the frame components. Mark out the final 2in. length of the frame from the trued end, return it to the lathe and finish to length.

Drill the bottom plate for the T-bolt holes and slots, using a 1/4in. dia. drill. Finish the slots by filing. This arrangement of mounting holes and slots will allow the head to be mounted on the cross slide either on the same axis as the lathe spindle or transversely. The two slots allow some adjustment of the bolt positions when the head is mounted transversely. The T bolts should be 1/4in. long 2BA hex socket head bolts, with square nuts (these are the standard T-bolts used on the Peatol). Drill and file matching slots in the top plate to admit the Allen key.



Cut a 2in. length of $\frac{1}{8}$ x $\frac{1}{8}$ in. brass strip for the register plate, shown in Fig. 4. Form the slots by drilling two $\frac{1}{8}$ in. holes $\frac{1}{8}$ in. in from each end, on the centre line of the strip, followed by hacksawing and filing to the edge to finish. Drill and tap the two holes in the backplate to take the M4 mounting/adjusting screws and fit the register plate to the frame, with its lower edge projecting about $\frac{1}{8}$ in. below the lower surface of the base plate.

Scribe a vertical centre line on the front plate to act as a guide line for drilling the holes for the bearing inserts. Fit the frame to the cross-slide with the output shaft axis parallel to the lathe bed, sliding it towards the headstock before tightening the T-bolts, to ensure that the register plate makes proper contact with the right-hand edge of the cross slide. Fit a drill chuck to the lathe headstock and fit a No.1 centre drill in the

chuck. Adjust the cross-slide so that the centre drill will split the scribed line, then lock the cross-slide and centre drill the front plate. Follow this by step-drilling through both front and back plates, to a final dia. of $\frac{1}{8}$ in. Remove the main frame from the cross slide and turn two brass inserts $\frac{1}{8}$ in. thick and nominally $\frac{1}{8}$ in. dia.; these should be a good press fit in the front and back plates and will form the output shaft bearings. Clearly, Oilite bushes, bored to $\frac{1}{8}$ in., could be used for this purpose, and in fact on my first attempt I did just that. I was unhappy about the fit of the shaft in these bearings, owing to a little over-enthusiastic turning on its bearing surfaces, so I removed the original bushes and replaced them as described. The result has proved quite satisfactory, and is considerably cheaper, particularly if you haven't destroyed two perfectly good Oilite bushes in the process! Fit the inserts to the frame, return the frame to the cross slide and repeat the step-drilling operation, to a final dia. of $\frac{1}{8}$ in.

The front plate is not drilled and tapped for the brake shoe mounting screws until after the output shaft and brake shoe have been constructed.

Constructing the output shaft

Fig. 5 shows the output shaft, and in dotted outline, the original form of the 1MT drill chuck arbor from which it is derived. It is possible to make this part the hard way, turning it down from suitable stock, say $\frac{1}{2}$ in. MS, but the approach adopted here

was chosen because it removed the problem of cutting an accurate $\frac{1}{8}$ in. x 24TPI thread, a tricky operation on a lathe that has no screwcutting facilities! Other approaches, for example using a $\frac{1}{8}$ in. x 24TPI die to cut the thread, were considered and rapidly discarded on grounds of the difficulty involved in maintaining any reasonable degree of concentricity between the resultant thread and the remainder of the shaft.

Turning the shaft is a simple matter of mounting it between centres; the free arbor I received from Tracy Tools was centred at each end, so this was no problem to set up. The turning is otherwise straightforward, as follows:

Turn the thick end of the 1MT taper to form the brake drum, $\frac{1}{8}$ in. diameter. The length of the brake drum section, nominally $\frac{1}{8}$ in., should be left marginally in excess of the thickness of the "brake shoe" material to avoid the thrust bearing being formed on the front face of the brake shoe. Turn the remaining length of the taper, nominally to $\frac{1}{8}$ in. dia.; I chose to reduce the shaft dia. slightly between the two bearing surfaces to ease assembly, but this is not essential. Reduce the dia. of the shaft beyond the rear bearing surface to $\frac{1}{8}$ in., to carry the wormwheel. The final $\frac{1}{8}$ in. or so of the shaft is further reduced and threaded M6 to take the locknuts which will hold the wormwheel in place. The two bearing surfaces and brake drum should be reasonably well finished; a final polish with

SURPLUS SIMILARITIES

When buying surplus or second-hand taps and dies, if NF or NC threads are encountered, these are essentially the same as corresponding UNF or UNC threads with the exception of 1in. NF which has 14 tpi whilst 1in. UNF has 12 tpi.

Alan Jeeves

a burnisher would be ideal. The aim should be to obtain a shake-free running fit in both bearings; if in doubt, err on the tight side, as the bearings will inevitably bed in to some extent in use.

The wormwheel, shown in **Fig. 6**, is a standard HPC part, 32 DP, 30 teeth, part number M32-30, in Brass, and takes the corresponding steel worm, HPC part number W32-1.

HPC also manufacture these parts in plastic at a lower cost; as the worm drive in this design is not required to take any significant load, I see no reason why the plastic versions should not be used, but I have no experience of using them. The worm and wormwheel are already bored for $\frac{1}{4}$ in. shafts; the boss of the wormwheel should be drilled and tapped M3 to take a pair of grub screws, positioned 90 deg. apart. A pair of flats are filed on the output shaft to match the position of the grub screws. The worm comes ready tapped for an M3 grub screw.

HPC are happy to provide small orders for the amateurs market, but impose a minimum charge of £15; their address is given at the end of the article. (*The total present day cost of the two items listed in this article is about £20.00 in metal and £12.00 in plastic. Both prices include VAT but not p&p - Ed.*)

Readers who feel the need for extra rigidity in the output shaft may choose to increase the shaft dimensions accordingly, along with corresponding alterations to the dimensions of the brake shoe/drum and the bearings in the front and back plates. The main limitation here (apart from the dimensions of the 1MT arbor) is that a reasonable shoulder is required between the front bearing and the brake drum, to form a thrust bearing.

The brake assembly

Figures 7-10 show the components of the brake assembly, and **Fig. 11** shows the completed assembly fitted in place on the front plate of the main frame.

The brake shoe, **Fig. 7**, is fabricated from $\frac{1}{4}$ in. thick aluminium; if it has been removed with sufficient care, the waste from forming the top plate of the main frame will suit very well. Cut and file the offset to size, 0.625 x 1.125in., to form the brake shoe. Mark the position of the $\frac{1}{4}$ in. hole and step drill to the final diameter. It is necessary for this hole to be a reasonably snug fit on the brake drum section of the output shaft, so it is worth experimenting on a piece of scrap to determine whether your $\frac{1}{4}$ in. drill will cut accurately enough; if not, make the final cut with a reamer.

Mark, drill and countersink the two holes to take the 4BA mounting screws. The countersinking should be deep enough to sink the 4BA screw heads flush with the surface. Clamp the brake shoe in position on the front plate, as shown in the assembly diagram, **Fig. 11**, with the output shaft inserted through the shoe and both bearings to ensure accurate positioning. Spot through the countersunk holes to mark the front plate. Disassemble, drill the two holes in the front plate and tap 4BA.

Cross-drill the brake shoe for the clamping bolt using a 4BA tapping drill, then carefully hacksaw along the mid-line as shown in the drawing, bisecting the hole

just drilled. Open out the left-hand hole to 4BA clearance, tap the right-hand hole 4BA. Fit the finished shoe to the front plate with 4BA csk steel screws. Refit the shaft, fit the worm wheel to the threaded end of the shaft, boss inwards, with a thin steel washer between boss and backplate. Oil the bearings. Screw the wormwheel grub screws in until they just register with the flats on the shaft (but do not tighten them yet), fit a 6mm nut on the end of the shaft and use it to adjust for zero end-float while still allowing the shaft to turn (a little stiffness in the bearings is not a problem), tighten the grub screws and finally lock with a second 6mm nut.

The brake clamping bolt, **Fig. 8**, is fabricated from a length of $\frac{1}{4}$ in. silver steel rod. Reduce the dia. of the last $\frac{1}{4}$ in. to 0.14in. dia. and cut a 4BA thread for at least half of the length. The next inch of the bolt is also reduced in dia., this time to 0.23in., to avoid contact with the front plate when the clamping bolt is fitted in position. Cut the bolt to a finished length of 2 $\frac{1}{4}$ in. and cross-drill $\frac{1}{4}$ in. to take the tommy bar. The tommy bar, **Fig. 9**, is simply a $\frac{1}{4}$ in. length of $\frac{1}{4}$ in. silver steel rod, threaded both ends 7BA (I discovered that $\frac{1}{4}$ in. rod happens to take a 7BA die very nicely!). The two end nuts, **Fig. 10**, are constructed from $\frac{1}{4}$ in. brass rod, $\frac{1}{4}$ in. long, drilled axially and tapped 7BA. The tommy bar is passed through the cross-drilled hole in the clamping bolt, the brass nuts are then screwed in place, using Loctite if so desired. The clamping bolt assembly may then be screwed into the brake shoe and its action tested; a half-turn or so of the clamping bolt in either direction should be sufficient to lock and unlock the output shaft.

The worm carrier assembly

Figures 12-15 show the components of the worm carrier and its associated mounting brackets. The worm carrier body, **Fig. 12**, is machined from $\frac{1}{4}$ in. square aluminium bar; cut a length of bar to allow finishing to 2.625in., face one end in the lathe, reverse and face the other end to length. Centre punch on one end the centre of the hole for the shaft bearing; this should be $\frac{1}{4}$ in. from one edge and $\frac{1}{4}$ in. from the adjacent edges. Return the bar to the 4-jaw chuck and adjust so that the punched dot lines up with the tailstock centre (assuming that the tailstock is accurately in line with the headstock...). Turn the last $\frac{1}{4}$ in. of the bar to $\frac{1}{4}$ in. diameter. At the same setting, step drill the entire length of the bar to $\frac{1}{4}$ in. dia. using the tailstock drill chuck. This requires some care and patience to avoid the drill wandering off line, but there is sufficient adjustment available in the positioning of the mounting brackets to cope with some inaccuracy here.

The next operation involves removing a considerable amount of material from the mid-section of the carrier to make a channel for the worm. This is most easily done using the milling attachment (vertical slide) or a milling machine, but is quite a simple (if energetic) job with hacksaw and file. The channel should be finished to the length of the worm, nominally 1 $\frac{1}{4}$ in. long, starting $\frac{1}{4}$ in. from the square end of the bar. The drawing shows the channel depth as 0.575in., which gives ample clearance for the worm.

The worm carrier bracket, **Fig. 13**, is

constructed from a 2in. length of $\frac{1}{4}$ x $\frac{1}{4}$ x $\frac{1}{4}$ in. aluminium angle. Two holes are drilled and countersunk for 4BA CSK screws on one face; these holes are used to mark the positions of the 4BA screw holes on the worm carrier body, which are then drilled and tapped. Two slots are cut in the other face of the bracket, as shown. The slots will carry 4BA screws/washers which screw into the corresponding holes in the main frame bracket (**Fig. 13**). Assemble worm carrier body and worm carrier bracket using two 4BA csk screws, as shown in **Fig. 16**.

The bearings used in the prototype were Oilite bushes, $\frac{1}{4}$ in. long, $\frac{1}{4}$ in. inside dia., 3/8in. outside dia., supplied by HPC Gears, part number QT 172-1. Insert the bearings into the two ends of the worm carrier body; they should be a push fit. If necessary, use Loctite or a similar retainer. As with the main spindle bearings, there is no good reason why these bearings cannot be turnings from suitable dia. brass rod.

The worm shaft, **Fig. 14**, is a 2 $\frac{1}{4}$ in. length of silver steel rod; face one end and lightly chamfer the edge, reverse it in the lathe, cut to length. Centre drill the end with a No.1 centre drill, then drill into the end $\frac{1}{4}$ in. deep, using a 4BA tapping drill, tap the hole 4BA. Two flats need to be filed on the tapped end of the shaft, as shown in **Fig. 5**, to allow the slot in the indexing arm to engage with the end of the shaft. The length of the flat is shown as $\frac{1}{4}$ in., but the requirement is that it does not exceed the thickness of the indexing arm.

The worm and its shaft can now be assembled in the carrier, as shown in **Fig. 16**. A flat can be filed at a suitable position on the worm shaft to take the grub screw. Any end-float in the worm shaft is dealt with by withdrawing the shaft far enough to insert washers of shim material between the end of the worm and the carrier and reassembling.

The main frame bracket (**Fig. 15**), is a 2in. length of 1 x 1 x $\frac{1}{4}$ in. aluminium angle; 5 slots are cut in one face, as shown. The larger of these slots match those on the top plate of the main frame; the three remaining slots carry 4BA screws and washers which screw into the corresponding holes shown on the top plate. The bracket can be used as a marking guide for the screw holes on the top plate, which are then drilled and tapped 4BA. Temporarily fit the bracket to the top plate with 4BA screws. Two holes are drilled and tapped 4BA on the other face of the bracket. Use the slots in the worm carrier assembly as a marking guide; this allows a check to be made on the engagement of worm and wormwheel, and any necessary adjustment made by altering the position of the holes before drilling.

The worm carrier and brackets can now be assembled with the main frame and adjusted to their final positions; the aim should be to position the brackets for minimum backlash in the worm drive, and to ensure that worm and wormwheel are properly aligned.

Supplier addresses:

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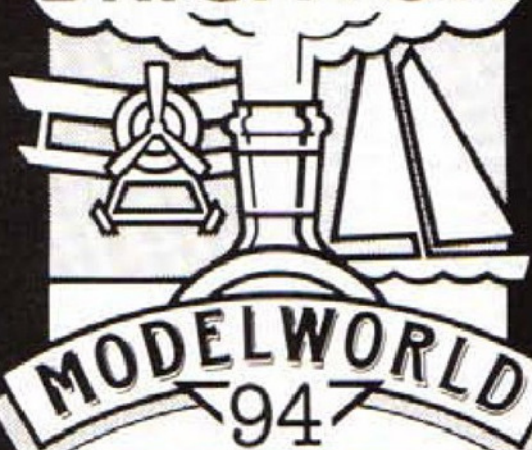
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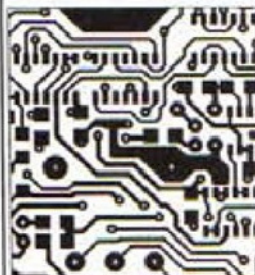
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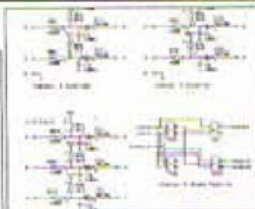
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USING A BENCH PRESS

PART 3

In this, the final part of the series on bench presses, the Author's methods of operating are explained. Of considerable interest, are the findings regarding the making and using of unhardened punches and dies for punching holes. These findings should make the owning of a bench press an even more attractive proposition than first envisaged.

We have so far discussed the capabilities of a bench press but without detailing the procedures for its operation. However, with understanding of a few basic facts, operating a bench press is really very simple, it in no way compares with the complications of using a lathe or a milling machine.

Also included in this final part, and by far its most interesting aspect, are some findings regarding making one's own punches and dies. These are as a result of some tests using unhardened punches and dies which have been carried out since the first two parts were written.

Operating a fly press

The following brief comments explain the basic approach to operating a fly press; they can be considered largely appropriate no matter what type of press is being employed.

Setting up for hole punching

Setting up a press for operation consists of a number of simple adjustments; the first, requiring only infrequent attention, is to ensure the ram is totally free of any play in its slide. Considering that when punching thin materials, say 0.25mm thick, the recommended clearance between punch and die will be only 0.025mm on diameter. In this case, if any play is present in the movement of the ram, it is possible for the punch to foul the die with disastrous results.

Having eliminated play in the ram, the next requirement is to ensure the punch enters the die centrally. As the die is first positioned loosely on the bed of the machine, not to precision standards, this does not occur automatically. To do this, the punch is firmly held in the holder which is then fixed into the ram; the die is fixed to the bolster, which at this stage is only loosely placed on the bed of the press.

Bring the punch down to just clear the top face of the die, then lift the bolster and

adjust its position until the punch enters the die. Now drop the punch down by about 3mm and let the bolster rest back onto the press bed, the punch will now be in the die. Very lightly tighten the bolster to bed fixings, and adjust the position of the bolster by lightly tapping in appropriate positions, such that the punch can be seen to be central in the die. With this done the bolster fixing screws can be fully tightened, and re-checked just to be on the safe side.

In the first part of the series, it was explained, that with the correct punch to die clearance, a satisfactory result was indicated by a clear line between the upper and lower parts of the hole. The upper part has a shiny appearance whilst the lower part is rough, if the punch is central the dividing line will be at the same height around the hole, and at about half the material thickness if clearance is correct. If the shiny portion is much closer to the under face, this indicates that the clearance is insufficient for the thickness of the material being punched, though if even all the way round it is probably OK for a few holes.

If the shiny portion is only closer to the under face for part of the circumference, the punch is not central, again, providing that the punch is not fouling the die, this is probably OK for a few holes. If a number of holes are to be punched it will be worth attempting to achieve a more accurate result.

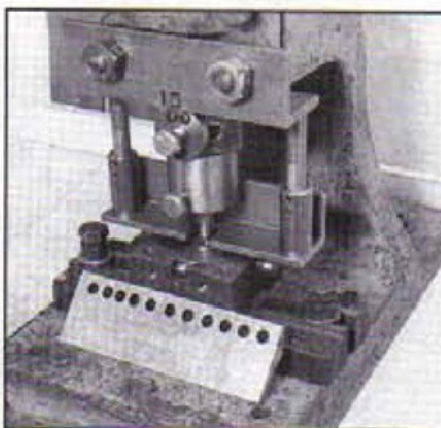
Having now set the punch and die adequately, the stripper can be set. Comparison of the photos (Nos. 19 and 20) showing the stripper in this issue, with



20: The stripper plate separated from the press and in its two main assemblies.

be punched. The adjustable stripper allows, in most cases, for the stripper to be lowered to provide just sufficient room for the thickness of material.

With the punch and die set in position and the stripper adjusted, it is possible that the handle will not be in an ideal working position. This can make operation difficult, particularly if it turns out to be behind the press. The top of the ram operating screw is provided with a tapered hexagonal portion, being smallest at its outer end. The central boss of the handle is provided with a matching tapered hexagon, permitting it to be removed and repositioned in one of the six positions, this can be seen in photo 21. The handle can



19: Showing the stripper plate now fitted with height adjustment, compare this with photo 10 in the first part of this series.

that in the first part, will show that it has been modified to include height adjustment. This is by no means essential, but if fixed, the clearance has to be set high enough to accommodate the thickness of any edge guides that may occasionally be fitted below it. As a result of this, to raise the ram sufficient to strip the workpiece from the punch, will necessitate the handle to be wound back quite a long way, this can be irritating if a number of holes are to



21: The top of the feed screw showing the hexagonal taper for positioning the handle. Note also the fine thread, in addition to the coarse thread, that permits the down feed stop to be adjusted.

thus be located, in a more convenient, if not ideal working position.

In the case of some operations the movement of the ram must be limited to a

definite depth, probably the most easy to understand being when parts are being bent to less than 90 degrees. To achieve this, the amount by which the upper blades enter the lower vee must be less than the amount than would be the case if the part was being bent to a right angle. To ensure that a number of parts can be bent to the same angle some form of stop is required.

The close up photo of the operating screw (photo 21) shows that in addition to the coarse thread that operates the ram, there is also a fine thread. The photo shows that there is a stop placed on the fine thread that can be adjusted to stop the ram at a precise position. When punching holes using the press near to its maximum capacity, the handle will be swung hard letting the weight take the punch through the material. In this case it will be essential that the stop is set, otherwise setting the stop when punching holes will be less important.

Finally it is necessary to set any workpiece stops that may be fitted to ensure that the holes being punched are correctly positioned. This requirement was fairly well covered in the first part of the series and no more needs to be said at this time. However, the findings regarding unhardened punches, makes the possibility of using punches with a locating pilot a very attractive proposition; more about that later.

With the press now set for hole punching, one is about to experience the considerable ease, and speed, with which holes can be made by this method. The quality of the hole will also be better than can be achieved by drilling; particularly for the larger sizes. In fact when drilling holes one is limited to a size of around four times the material thickness, punched holes of up to 40mm diameter in thinner materials will present no problem. The punching of holes using a press will only be limited by the size of the through hole in the bolster, and the pressure available from the press.

Setting up for bending

Setting up for bending is somewhat simpler, place the blade in the ram and tighten, bring this down fully into the vee placed loosely on the press bed. This action will centralise the blade into the vee, which can now be fixed in place on the bed.

If a number of parts are to be bent and the bend is less than 90 deg., the depth may require setting as mentioned above. Again if a number of identical parts are being made, setting a rear stop on the tooling will be beneficial. If the part being bent is only a strip, a side guide will help to ensure the bend is at right angles to the length of the strip.

Punches and dies

The design of punches and dies is quite straightforward; only a small number of conditions requiring to be met, even where they are more appropriate to mass production, rather than the odd few pieces which we will in all probability require. The requirement for a clearance between punch and die have already been mentioned. This is nominally 0.1mm per 1mm of material thickness. Experimentation will show that there is a fair degree of tolerance on this value.

The next point to be observed is that the hole produced will be equal to the punch

size, and the piece punched out equal to the die size. It is probable that in almost all cases it will be the hole which is of importance, and so it will be the punch that requires to be to the required size. If on the other hand it is the blank which is important, then the die must be made to size.

The punch must be parallel and, if of a small size, the actual portion made to the required diameter must be as short as is practical for maximum strength. Of course the length initially made must allow some extra for sharpening. The transition between shank diameter and punch diameter must be a generous radius, particularly if the tooling is to be hardened.

The die must also be parallel for at least part of its depth. However, it is essential that after about 5mm of depth the size is opened out a little. The purpose of this is to make it easier for the blanks to be released from the die. If the die was parallel throughout its thickness, probably around 15mm, then there would be a large number of blanks to be forced through, all adding to the pressure required to complete the operation.

For a round die the hole size can easily be opened up with a drill from the rear, the size being around 1mm larger than the die size itself. My experience from the distant past was for irregular shaped dies to be opened up using a filing machine set to an angle of a degree or two; the parallel portion was often finished, also using a filing machine. I have no doubt that milling out the clearance using an end mill would be acceptable; it may be more prone to causing dies to split during the hardening process, due to the sharp corners. The unhardened dies to be mentioned later would not suffer from this problem.

Unhardened punches and dies

It was mentioned in the first part, that the disadvantage of using a bench press for the punching of holes was the high cost of the punches and dies. As a result of tests, carried out since writing that first part, using unhardened punches and dies,

it has been found that for short runs at least this statement is not entirely valid, unless large numbers of holes are to be made or thick material is being worked.

Before detailing the results of the tests a few facts are worth highlighting. The pressure taken to punch a hole is not affected greatly by the sharpness of the edge, therefore the early wearing of the unhardened punch and die will not have much effect on its operation, providing the wear is not excessive.

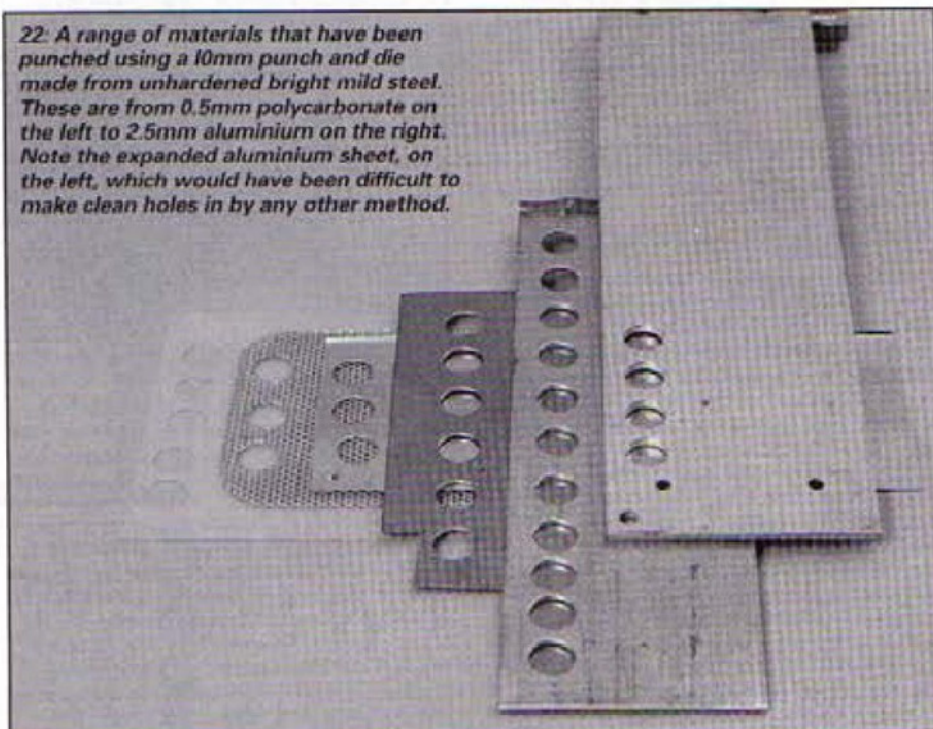
The formulae for the pressure required to punch a hole is, $\text{Pressure} = \text{Length of periphery} \times \text{Material thickness} \times \text{constant}$ (this figure varies, depending on the material being worked). This will be dealt with in greater detail at the end of the article.

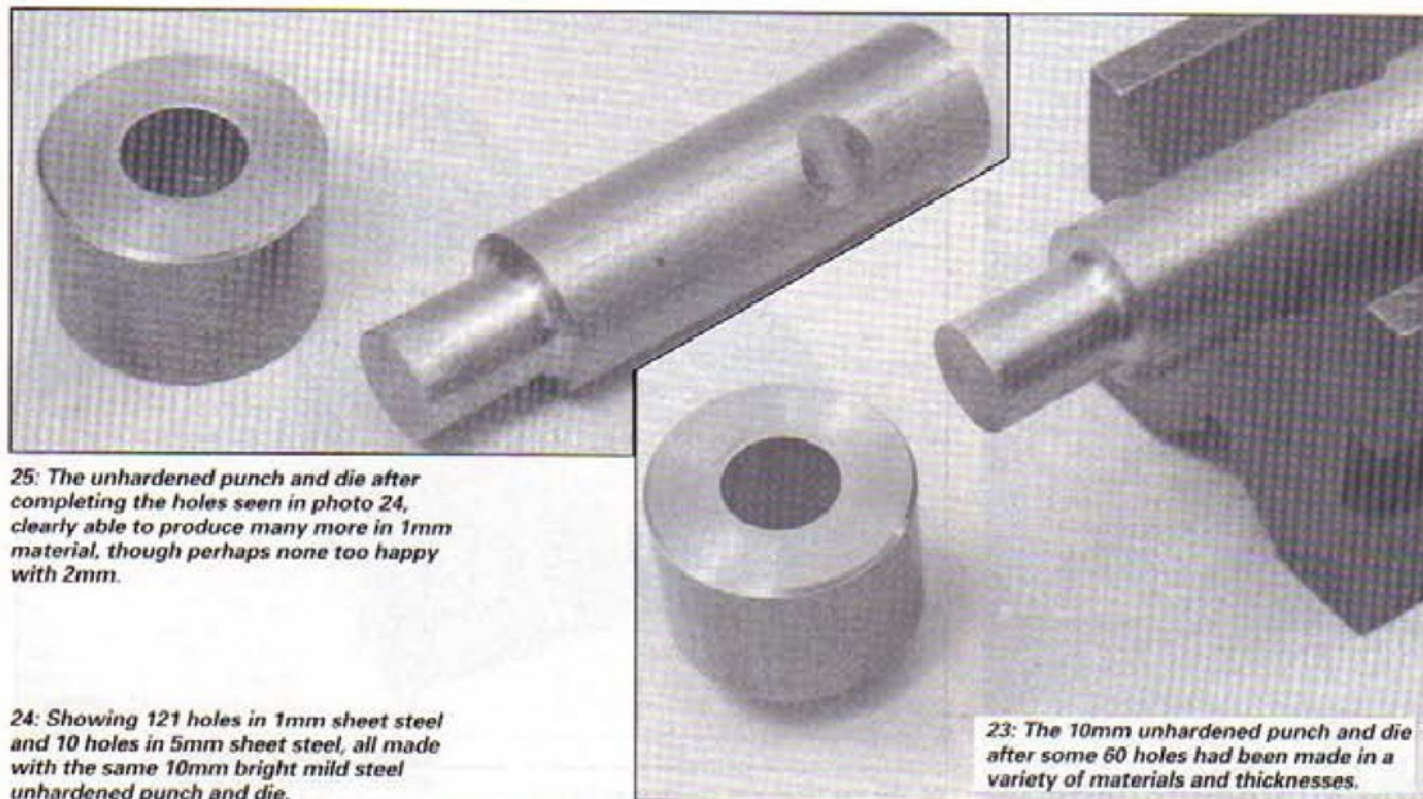
From this it can be seen that, for a given workpiece and material thickness, the pressure per given portion of cutting edge is a constant. As a result the ability or otherwise of an unhardened punch and die to function satisfactorily will be independent of the size of hole being made, as the edge loading per given length is a constant. Typically, if a satisfactory result is obtained with a 10mm punch in 1mm sheet steel there is no reason for a 30mm hole in 1mm sheet steel not to work equally well.

Now let us consider the actual tests carried out. I had no doubt that an unhardened punch and die would work very well in thinner and softer materials such as polycarbonate, copper and aluminium, perhaps up to 0.5mm thick; what I was unprepared for, was how well it would work in more arduous conditions. First, I made a punch of 10mm dia. and a die with a clearance of 0.1mm over the punch, both made from free cutting mild steel, probably EN1A.

These were set up in the press and a few holes punched through a sheet of 0.5mm polycarbonate with total success, this was followed by similar results with 0.5mm aluminium. I followed this by punching holes in a sheet of expanded aluminium; this not surprisingly also turned out very well. However it did serve to show the benefits of using a bench press for this

22: A range of materials that have been punched using a 10mm punch and die made from unhardened bright mild steel. These are from 0.5mm polycarbonate on the left to 2.5mm aluminium on the right. Note the expanded aluminium sheet, on the left, which would have been difficult to make clean holes in by any other method.

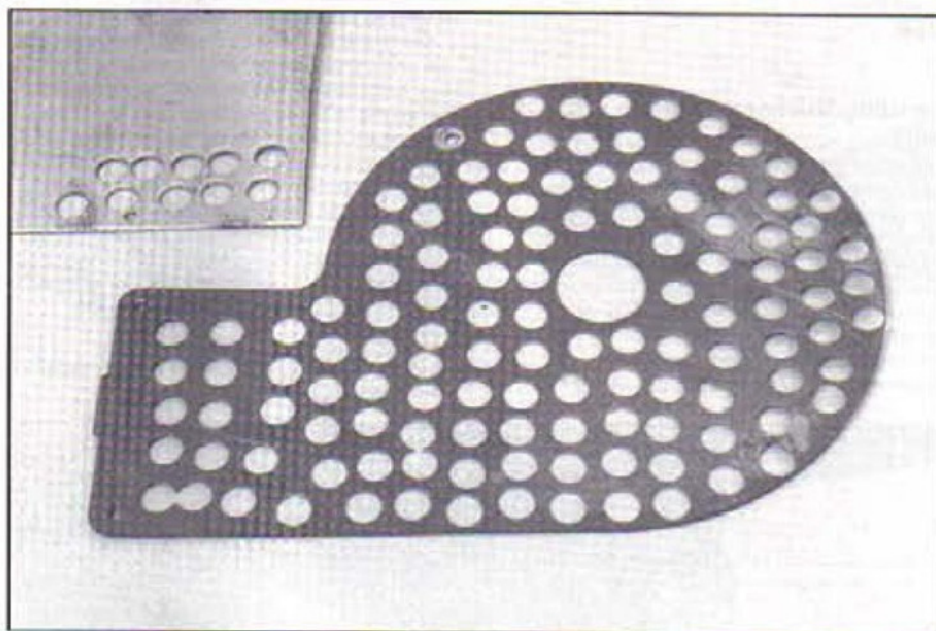




25: The unhardened punch and die after completing the holes seen in photo 24, clearly able to produce many more in 1mm material, though perhaps none too happy with 2mm.

24: Showing 121 holes in 1mm sheet steel and 10 holes in 5mm sheet steel, all made with the same 10mm bright mild steel unhardened punch and die.

23: The 10mm unhardened punch and die after some 60 holes had been made in a variety of materials and thicknesses.



became more ambitious and used a piece of 2mm sheet steel the hole in this was very adequately accomplished. I followed this with a few more holes in the same material. At 10mm diameter and 2mm thick steel the handle did require a firm pull, but was still far from the limit of the press. Even so, this seemed a bit extreme for the majority of holes that would be expected to be punched in the home workshop, it was decided to return to the 1mm thick steel and attempt to produce a large number of holes.

The sample sheet that was being used, seen in **photo 24**, was then plastered with holes, and this continued, still with no sign of it becoming difficult. When finished the number of holes in the plate numbered 121, and the final hole was virtually indistinguishable from the first one, there being just a slightly greater burr on the rear of the later holes. This was a very encouraging result and there appeared no reason why at least another 200 to 300 holes could not be made, probably even more.

With so much success it was obviously right to attempt to demand even more of the set up, so the 2mm steel plate was returned to the press. Having now made so many holes in the 1mm plate it may be considered that it would not be unhappy in the thicker material, this did not prove to be the case. Punching further holes in the 2mm material could still be done with relative ease and success.

However after 10 holes, as can be seen in **photo 24**, it was noticed that the rear edge of the hole was becoming progressively raised, rather like the reverse of a saucer.

Close examination of the die, seen in **photo 25**, showed this to have the reverse effect, having a dish area around the cutting edge, the width of this being about 1mm. The reason for this was obviously due to the increased loading per length of cutting edge, as a result of the increase of material thickness from 1mm to 2mm. This increased loading was obviously sufficient to cause the edge of the hole to become

operation; this would have been quite difficult to achieve by any other means at my disposal.

With such an encouraging start, the thickness of the material was gradually increased, using 1mm, 1.5mm and finally 2.5mm aluminium, followed by 1mm brass. In this series of tests I punched some 60 holes, some of these test pieces can be seen in **photo 22**. With such encouraging results it was time to take the plunge and try some steel, first tinplate was attempted, followed by 10 holes in 1mm sheet steel, with no loss of effectiveness from the punch/die combination.

I considered that it was a good idea to inspect the punch and die closely, so they were removed from the press. On close inspection I could see that the sharp edges produced by the turning of the parts had been lost, but only very slightly, **photo 23**

shows this situation. When comparing this factor with the hardened punches and dies I had, which had been very well used, perhaps even abused, by the previous owner, my latest addition still appeared in very good shape. I measured the end of the punch with a micrometer and found that it had "grown" by about 0.02mm. When held up to the light, whilst still between the micrometer anvils, I found that the end had mushroomed very slightly; doubtless the die would have exhibited similar slight deformation, had I the equipment to measure this accurately.

The set was returned to the press and a few more holes made in the 1mm sheet steel, still with no problem. It is worth adding at this stage that the holes were being produced with little more than a light tug on the handle. The press was still operating well within its capacity. I now

distorted. However the holes were still of good quality, and if the small raised portion (measuring 0.07mm high) at the rear was acceptable, then perhaps 40 or 50 holes, maybe more, would be possible. Whilst 2mm was near to the limit when steel was being worked, thicker material would not be a problem with softer materials.

Being soft, both punch and die could easily be sharpened by returning to the lathe and skimming probably no more than 0.2mm from the end of the punch or the face of the die. If they become badly worn then punches can be re-used to make smaller punches, and dies to make larger dies.

Using a pilot

Another distinct advantage of this approach would be the possibility of making punches complete with pilot, so that this can be located in small holes previously drilled, this method would aid the accurate positioning of larger holes. If the pilot was made removable, the punch could also be used where use of a pilot is inappropriate.

Considerably increased use

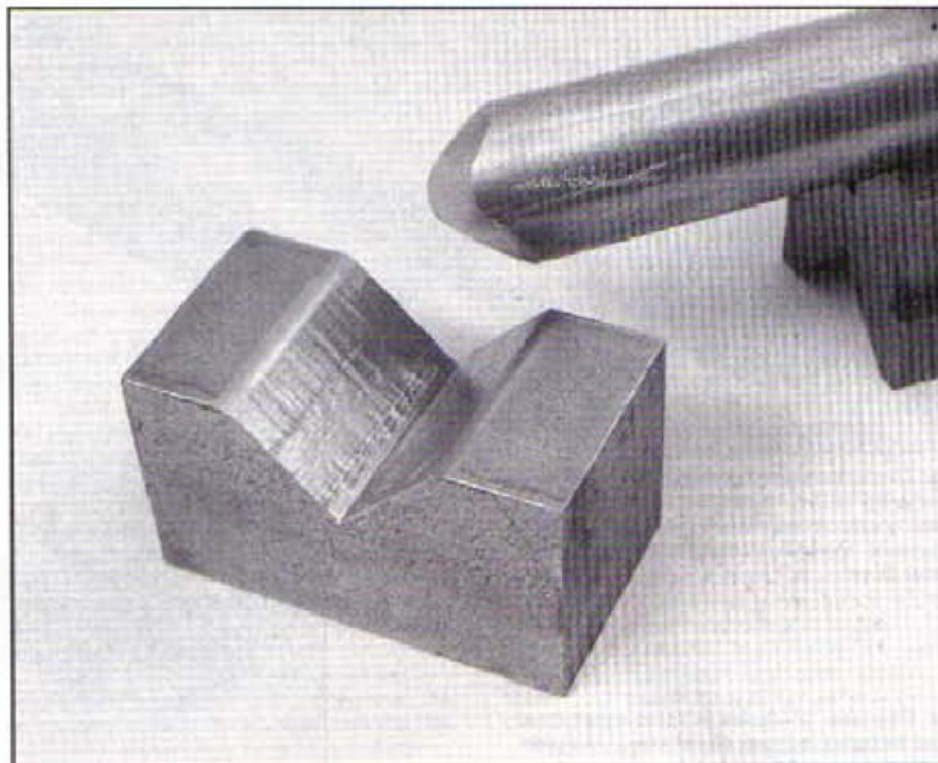
Whilst expecting good results in aluminium and copper, I must confess that the findings with regard to punching sheet steel have come as a very pleasant surprise. As a result, I feel this has considerably increased the potential for use of a bench press in the home workshop. Even making a punch and die for a one off hole of larger size, would be easier than making the hole by most other methods. The resulting hole would also be of high quality and as precisely sized as the tooling.

Specially shaped holes

In very special situations for a one off hole and definitely where a number of holes are to be made, either rectangular or some irregular shape, making a special punch and die would be worth considering. This is not as difficult as one may envisage, the following brief explanation may be helpful.

It is probably easier if in this case a compromise is made and the punch shaped and hardened. With this done the die can be started and the hole made roughly to shape but definitely undersize. Offer the punch up to the surface of the die and carefully scribe around the punch marking the die. Carefully file the hole very close to the mark, following this the punch can be used as a broach to open up the hole, doing this in the press itself. Do however only let the punch enter the die by no more than 0.5mm, remove and now file up to the broached edge. Again offer the punch up to the die and this time, providing there is not too great a difference between punch and die, force the punch fully home. The punch will now be a tight fit in the die and will require forcing out from the other direction. Now gradually file around the inside of the die until sufficient clearance is present.

As has already been said, the amount of clearance is not so critical as the suggested values would indicate, so this should not be too difficult. A small filing machine is ideal to ensure the sides are upright, but if being done by hand being smaller it would be better to aim for a small taper towards the top of the die.



26: The vee block and punch used to test bend 25mm x 3 and 5mm thick bright mild steel.

made with a vee of 90 deg. and the blade to 90 deg., or a degree or two less.

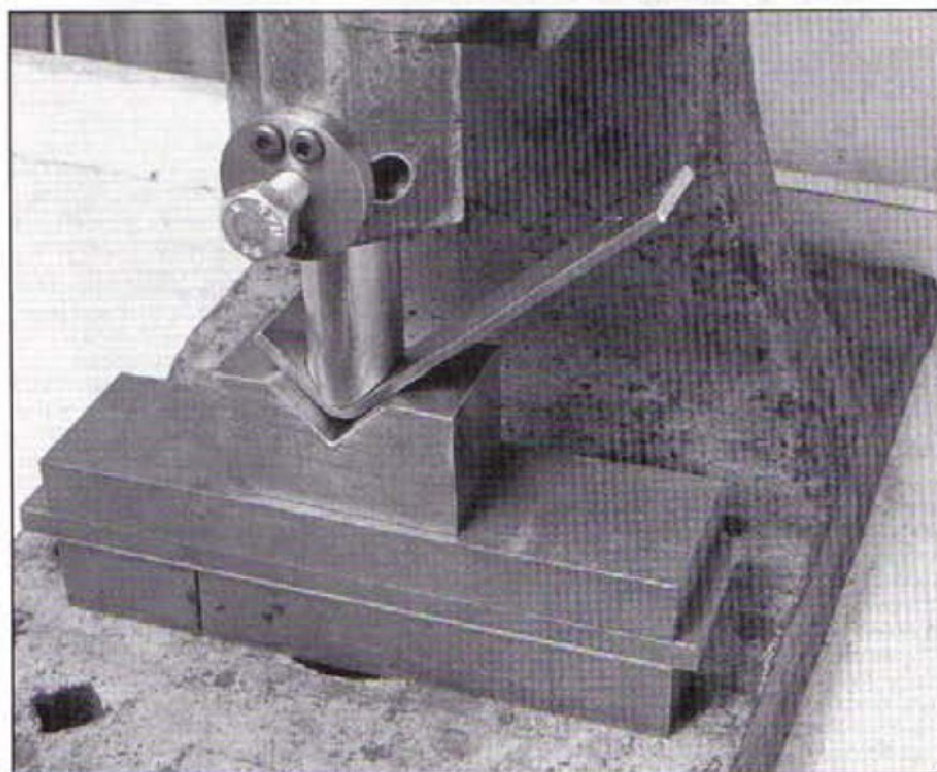
On this basis, it was decided to make the vee and the punch 90 deg. and see how they functioned. The hole in the ram being 25mm dia. a piece of 25mm dia. mild steel was cut to a suitable length and a vee machined on the end. A flat of about 3mm was left between the two sides and after the punch was removed from the milling machine, the flat was carefully filed to provide a radius of around 3mm.

A 90 deg. vee was milled across a short length of 40mm square mild steel, the

Bending thicker materials

Having had so much success with the use of unhardened punches and dies, the test bending thicker materials was perhaps not such an outstanding success. I learnt some valuable lessons, so it could not be regarded as an absolute failure. The aim was to bend materials about 25mm wide and up to whatever thickness proved possible. As was mentioned in Part 2, commercially available vee benders for sheet metals, steel, aluminium etc. are

27: A bend being made in 25 x 3mm bright mild steel.



width of the vee at the top being 32mm. When removed from the milling machine the two top edges of the vee were radiused, again to about 3mm. The punch and vee block are shown in **photo 26**.

The punch was fixed in the ram and the vee placed on the press bed. The punch was then brought down to centralize the punch into the vee, for a one off bend there is no need for the vee to be firmly anchored. The first attempt was to bend a piece of 25 x 3mm mild steel, see **photo 27**, this started to bend without the need for undue force; unfortunately a crack occurred just prior to the bend reaching 90 degrees. The test was then repeated with a length of 25 x 5mm with the same result, both seen in **photo 28**. In this later case, the force required to make the bend was as much as one could apply without actually swinging the handle, as is often done when using a fly press, this action requires a very strong bench.

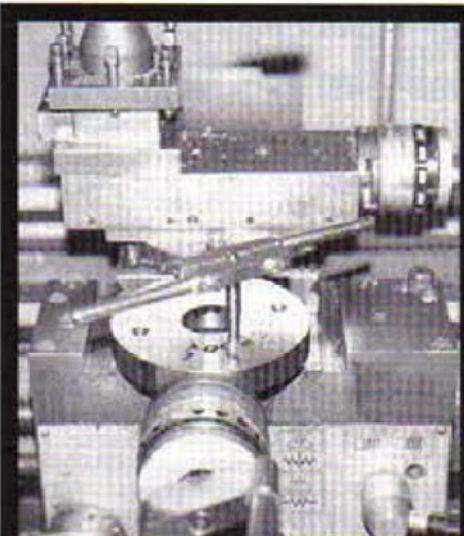
Having failed with the first test, the radius on the end of the punch was increased to around 6mm and the test repeated. This time the 3mm thick mild steel bent without cracking, as can be seen in **photo 29**, it was also accomplished

with ease. Unfortunately due to spring back it finished up with an angle of 84 degrees.

The 5mm thick workpiece bent further before cracking than in the first test but still cracked just prior to bending the full amount possible. It still required a substantial pull to complete the bend. If a satisfactory bend is to be made in the 5mm material then an even larger radius would be necessary on the punch, and to achieve this with less effort the vee in the base would require to be substantially wider, I would estimate 45mm at least.

Another approach to obtaining a satisfactory bend would be to anneal the material by heating to a red heat and allowing it to cool slowly prior to bending. The grade of steel being used was not fully known but was some form of machining bright mild steel. However if a quantity of parts are to be made bending quality mild steel is available which should be obtainable from any reputable steel stockholder. Surprisingly this material is not to any British or international standard, the well known steel stockholder Macreadys stocks this as bright steel flats bending quality with a name of Usabend.

To overcome the problem of spring back

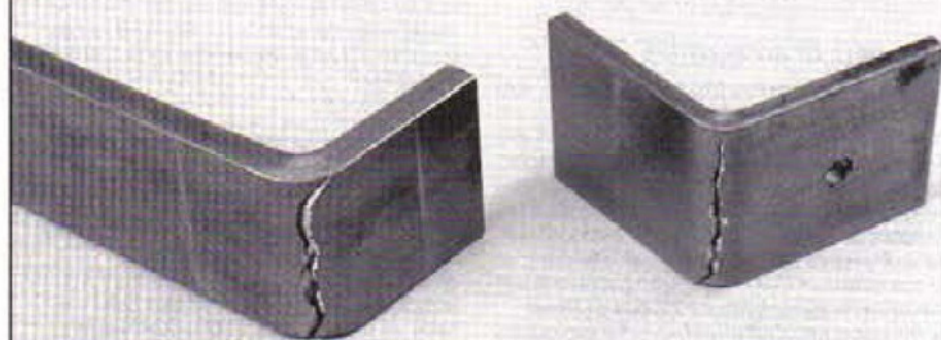


QUICK TIP

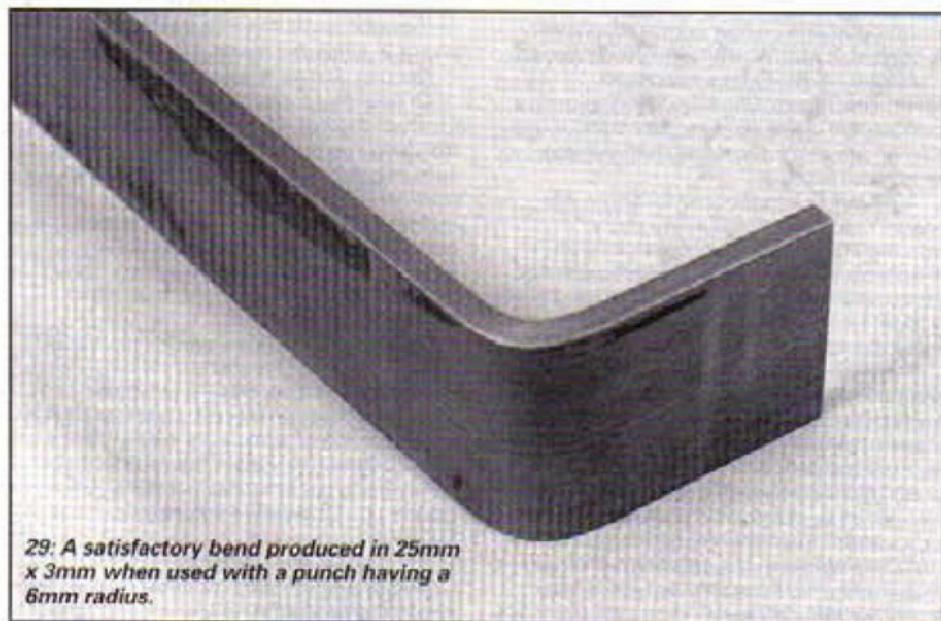
On some lathes, such as the Harrison M300, pictured here, a job can be sufficiently gripped between the cross slide and the handwheel housing in order to carry out operations such as tapping holes. A light grip is usually all that is needed and the "jaw opening" is a good deal greater than that of most small vices.

Alan Jeeves

28: Using normal bright mild steel, non bending quality, bend cracked, in both 3mm and 5mm thick materials, when using a 3mm radius on the end of the punch.



29: A satisfactory bend produced in 25mm x 3mm when used with a punch having a 6mm radius.



the punch and vee could be made with an angle of less than 90 deg., however this would be difficult in the case of the vee without the use of a special cutter, and in any case what would the angle require to be, I suspect it would have to be different with changes in thickness and type of material. The solution would be to adopt the method shown in Part two where the vee was substituted by a rectangular slot, the angle bent would then depend on the depth that the punch entered the slot.

Conclusions

I do hope these remarks on the uses of a bench press may help readers to appreciate the benefits of owning one, and now that it has been found that the cost of punches can be considerably reduced, the cost is not that great if a small second hand fly press is obtained. If space is a problem, then the lever presses of the types available from Manuform and Hunton would be ideal but more expensive. With some care perhaps an Arbor press could be adapted, but play in the ram may present a problem, and as purchased there are no fixings, tapped holes etc, on the bed for holding the bolster or bending vee block. If cash is in short supply almost all the necessary accessories can be made by the reader.

Hole punching tonnage

Tonnage = circumference (mm)
x thickness (mm) x constant
Constant = Shear strength - Mild steel: 0.04
- Copper: 0.02
- Brass: 0.03
- Aluminium:
0.02

These values are approximate only, and will vary with differing grades and states of the material, this will be particularly so for aluminium. In many cases the actual tonnage will be less than the value calculated from the above.



SCRIBE A LINE

Your views, your pages! Your opportunity to make your point, ask the question or simply pass on a snippet of interesting advice to others. Your letters for publication in *Model Engineers' Workshop* are always welcome

South Bend Lathes

The requests in *Scribe a Line*, issue 19, relating to South Bend lathes resulted in a large number of replies, indicating that these lathes are very popular. Many letters referred to the book *How to run a lathe* and others, to the similarity, and therefore interchangeability of spares, with Boxford lathes. The following are brief extracts from just a few of these letters.

The Address

From James Hotinger of Richmond USA who is also seeking help on another matter.

As the readers of M.E.W. were helpful in my quest to remove broken 10 and 12 BA screws, I felt obliged to return the favour. Several readers of late have requested information regarding South Bend Lathes. The address for South Bend is: South Bend Lathe, 400 West Sample St., South Bend, Indiana, 46601, U.S.A., tel. (219) 289-7771

I, too, have a 5in. South Bend and obtained several parts and an owners manual from them. In addition, I am aware of several other sources of parts - if the readers cannot get what they need from South Bend.

I also have a two requests. First, are any readers aware of sources of brass square and hexagon-head screws? What about steel square head screws in the 2 - 8 BA range. I am attempting to construct a Trevithick engine, and I will make the screws if I must.

Secondly, are any readers aware of plans to make a small shaper (5-8in. stroke)? Lacking that, are any readers aware of a source of a small shaper? I am looking for one of the hand or power operated ones such as an Adept. (We only know of one publication, Book 3 in the series, *Build your own metal working shop from scrap*. This is by Dave Gingery and is available from Camden Miniature Steam Services 13 High St, Rode, nr. Bath Somerset, BA3 6NZ, price £6.60 plus p&p - Ed.)

Another new reader

From Harry Reay of Houston, U.S.A.
Recently, while visiting my home town - Newcastle-on-Tyne, I picked up a copy of the Oct/Nov. 93 edition of M.E.W. In that issue, two of your readers, Mr. A.J. Reynolds and Mr. Barry Smith requested information in that edition regarding South Bend Lathes.

Enclosed please find three copies of SBL's Maintenance and Spare Parts Manual plus the cover page of their Operating manual, *How to run a lathe*.

I can speak from experience about the excellent service they will receive from SBL if they wish to contact them directly.

Congratulations on the quality and content of M.E.W. I plan to subscribe forthwith.

How to run a lathe

From Brian Crook of Staines.

Reading through my latest copy of M.E.W., I note that two of our fellow enthusiasts, (Mr A.J. Reynolds of Stevenage, and Barry Smith of Goring on Thames) are requesting information on the small South Bend lathe. Mr. Reynolds is justified in his pride of ownership as having used one of these lathes in the early part of my career and subsequently as an aid to my hobby of motorcycle and car restoration, I can assure them that these are superb machines capable of accuracy and speed. Many of the 1940s and 1950s lathes were based on it and its only drawback is the availability of genuine spares.

Information is very complete in the Southbend book, *How to Run a Lathe* which I have seen advertised fairly recently. (Available from Camden Min. Steam Services, address above - Ed.)

Failing that, the Boxford lathe book available from their excellent and courteous spares department covers all the essential technical detail of setting etc.

Suppliers of accessories

From S.J. Knowles of Telford.

With regard to your letters in the current issue of *Scribe a Line*, from Mr. A.J. Reynolds of Stevenage and Mr. Barry Smith of Goring-on-Thames. May I pass on some information which I discovered recently in another publication, *Strictly I.C.* a magazine for builders of model i.c. engines. A letter to the editor of this publication mentions the present availability of the South Bend publication dedicated to that lathe (spindle speeds, threading gear, metric conversion charts, etc.). Edition 56 of *How to run a lathe* revised 1966.

There is a company called Metal Lathe Accessories, Town Farm Outwood, Bletchingly, Redhill, Surrey RK1 4LR. They specialise in accessories designed for South Bend lathes; this information was published in M.E.W., Autumn 1990 page 29.

J Ward, F.T.C. Engineering who advertises in your Classified section makes a very good cross slide for that lathe - I use one. I hope this information helps these two fellow readers.

After being a toolmaker for some 40+ years - I've done things every day of my working life without thinking that other people don't know about it; I did something the other day and the person watching said "I didn't know that". I thought everybody knew. So here is that tip for your readers:

When opening up a hole with a bigger drill you may find that the drill bites or tries to grab the metal or tries to cut a hole the shape of an old threepenny bit. This is because the centre of the drill has nothing to cut. The way to stop it is simple; rip up a piece of emery cloth into a square that is bigger than the drill and place it between the hole and the drill with the rough side down, and drill. Save all your worn out emery for this purpose.

A satisfactory replacement

From L. Hockley of Bradford.
With reference to the *Scribe a Line* section of M.E.W., two readers are listed as requesting information on South Bend Lathes which are still being made. I have one which left the factory in 1964.

I brought some items direct from the U.S.A.; what you buy depends on how deep your pocket is, as whatever you buy will have VAT and import duty added to it when it reaches this country. Anyway most parts for the M.E. Boxford 10 lathes will fit Southbend lathes. My Southbend did not have a T slot cross slide so I bought one of Boxford's slides and found it was a direct fit with no hidden problems.

Similarity with Boxford

From D.H. Cooper of Liskeard.

South Bend published a booklet called, *How to run a Lathe*, which is a mine of information on the South Bend Lathe. It is listed by Camden Books.

Before the 39-45 war Buck and Hickman were importers of American machine tools including South Bend, but I think this side of the business has died. However soon after the war two British companies, Smart and Brown and Boxford produced lathes that were extremely similar to the South Bend design, and spares for these machines may well fit, with slight modification.

I would refer you to the adverts in M.E.W. and *Model Engineer* by G and M Tools, who list spares for Boxford lathes including change gears that fit South Bend machines.

Similar micrometers

R.F. Thompson of Paignton comments on the article *Micrometers with a difference*. Photographs mentioned in this letter appeared in the original article, we have no illustrations of Mr. Thompson's instrument.

After reading the Oct/Nov issue, I should like to make comments on two of the articles therein. The first, on unusual micrometers (page 32), caused me more than little surprise, since I have a micrometer which is virtually indistinguishable from that depicted in photo 2, albeit the name on the main anvil is The L.S. Starrett Co Ltd not Mitutoyo.

Of course, that company is American, located in Athol, Mass., U.S.A., although my instrument was manufactured by their subsidiary in Jedburgh, Scotland. I can confirm that it is a most versatile instrument, which in its time has seen me out of several jams. The essential differences between the Mitutoyo instrument and my own, may be listed as follows:-

- i) The barrel lock is operated by a knurled ring, rather than a lever
- ii) The shape of the main anvil in the vicinity of the end of the plunger, is slightly more 'cut away', which permits measurements on round bars up to 3/4in. (19mm) diameter, as distinct from only 12mm, as appears to be the case with the Mitutoyo instrument.
- iii) Two removable flat anvils were supplied, one virtually identical to that appearing in photo 9, and the other very

similar, but with a V notch at the end, to improve the seating when taking measurements such as that shown in photo 4, and particularly on smaller diameters.

The circular section rod, removable anvils, were located in a groove in the moveable clamp bar at the end; this may also be true for the Mitutoyo model. My own micrometer remains in pristine condition despite its age (about 20 years), and I attribute this to very low usage. This is not to say that I have found it a white elephant over that time, but rather that I have perhaps over indulged myself in alternative instrumentation, which is often more freely to hand. On the contrary, to one with less equipment, it would be of inestimable value.

Incidentally, I still have the original instructions, and find that my instrument was described as Multi T Anvil - 220 series.

The second matter surrounds Mr Longworth's article on the use of a three jaw self centring chuck, as, an extemporised boring head. I do feel that this is a valuable contribution:

a) It would be just the thing to fall upon, if confronted with the necessity to produce a bore in a large major project, which could not be swung over the lathe bed, and;
b) Implementation of the idea does not involve any major constructional distraction.

In my opinion, such articles are amongst the most useful features appearing in your magazine.

Of course, unless one is fortunate enough to have existing soft jaws for the chuck, their purchase becomes necessary, but I very much doubt whether the cost would compare to that of a boring head. My three jaw is a Burnerd, and I may say I am now toying with the idea of procuring a set of soft jaws for just the very purpose propounded by Mr Longworth. Although I do have a boring head, it is a relatively light affair, and I feel that the larger mass of the three jaw chuck could prove an inertial advantage. Moreover, the device suggested clearly has a much larger diametral capacity than my own purpose made boring head.

Adjustable die stocks

Another item from *Scribe a Line* in issue 19 brought in more than the normal number of replies. The letter was from Les Rix and related to adjustable die stocks. The consensus of opinion appears to be that it is a pity that they are no longer available, as with them it is easier to produce a straight, as opposed to a drunken thread. Here are just three from the letters received on this subject.

A sober thread

From the Rev. Ronald Hatfull of Hyde Lea. It is suggested that the tool described by Les Rix, issue No. 19, was, at one time, quite common. A workshop to which I had access some 50 years ago had a set of screwing tackle that comprised such a die stock and a set of pairs of dies for the usual Whitworth threads.

One part of the pair was butted up against the end of the rectangular opening in the die stock and the other was adjusted

by screwing up the handle.

The big advantage of this tool was that it was almost impossible to produce a drunken thread, as the dies were closed onto the rod to be threaded and, thus, were automatically correctly aligned. The movable half of the die was then advanced until the thread was cut to the correct depth.

Another advantage was that it was not necessary to file, or turn, a tapered "lead" on the end of the rod. Although of no practical use, it was even possible to cut a thread in the centre of an otherwise plain length of rod.

It is not known why this design of tool went out of favour and is not now listed; but I have often wished that I had purchased a set at the time.

The modern button die - split or solid - is an abomination, in particular for coarse threads. It is almost guaranteed to cut a drunken thread unless used in a die stock with a guide, or in a tailstock die holder in the lathe. A long "lead" is helpful, but it needs to be accurate and the resulting threaded rod may have to be trimmed to eliminate the "lead".

The modern die requires a lot more effort since the thread is cut in a single pass instead of gradually. This can be a serious matter when, for example, large Whitworth threads have to be cut.

One size only

From A.N. Claridge of Mickleover, Derby I write in response to the letter from Mr. L. Rix in the October/November issue.

I have a stock and set of dies similar to that described by Mr Rix. The dies cover the range from 1/4 to 1/2 in. Whitworth and are in matched pairs, numbered 1 and 2. They must be inserted in the correct order into the stock, which also has the numbers stamped on it. Each die block spans around 150 deg. and there is a slot about 1/16 in. wide in the middle so that each pair of dies has 4 cutting edges.

Mr Rix is not correct in assuming that a single pair of dies can be used to cut threads of different diameters. A little thought will reveal that the pitch angle of threads of a fixed TPI changes with the diameter. A separate pair is needed for each size. It is certainly possible to make new dies however. I use mine to cut new threads, to clean up damaged ones, and to extend the thread on bolts. I find that the ability to start a new thread with the dies barely touching the bar stock is useful in ensuring a square start, while the progressive cut is similar to that used in screwcutting in the lathe.

The history

From Alan Jeeves of Meltham.

Les Rix seems to have hold of a die stock known as the American pattern. They were introduced in the States around the mid 1800s and had interchangeable dies as Les will know. They were somewhat revolutionary at the time I suppose - I know that around the turn of the 20th century a set of 1/16 in. to 1/2 in. BSW dies (I think 9 sizes plus holder) cost £2-15s (£2-75) from the Britannia catalogue. This would probably equate to well over £300 today. A set of plain blocks with a V in each edge was available to use the holder as a tap wrench.

These tools became popular in the U.K. and were known as bevel dies. They were

stocked by tool merchants well into the 1960s, but were mainly BSP or BS Conduit by then. I have a 1964 catalogue with a full complement of sizes on offer from 1/16 to 1 1/2 in. (excluding BSP threads).

As to use, I suspect that Les has only one set of dies for it - 16 TPI. These should not be used to cover threads from 1/4 in. up to 1/2 in. but should (as may be indicated) be for one size of thread only. It will be 1/16 in. BSW, or either 1/8 or 1/16 in. BSF, or 1/16 in. UNC. They should be closed up and the thread cut in one pass.

When they became blunt or worn they were resharpened and part of the mating face, stoned off to re-establish size.

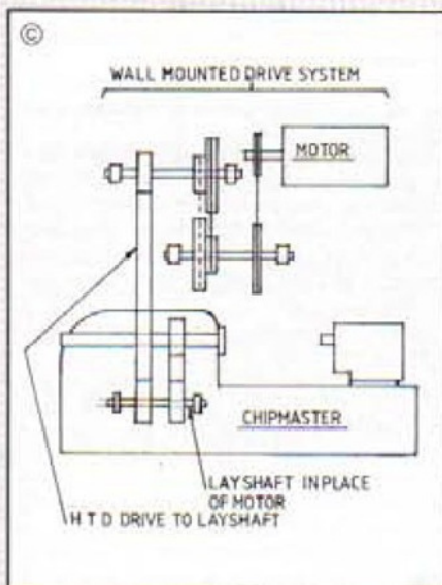
Circular dies have superseded this type of screwing tackle now but replacement dies are very common at steam fairs, autojumbles and the like (usually used).

They are not difficult to make. Simply produce the blanks out of high carbon steel, clamp the two together in the holder and carefully drill and tap dead centre with the thread required, and chamfer for the lead. Harden and temper and they are fit to use.

Chipmasters

A recommendation, and an idea, from David Dew of Kings Lynn.

There was a semi recommendation towards Chipmaster lathes in the article on the visit to Harold Newman in issue 18. There is a problem with replacements for the variable speed drive. Some years ago a secondhand tool merchant asked me to recommend an inverter for these machines. We wouldn't because it would



have little low speed power (power proportional to speed is not what is required on a lathe), nor were we happy to use the normal fan cooled motor growling all day at perhaps 5Hz (fan = cube law). A force ventilated motor, costing about £400, would be necessary. So, he claimed that there are loads of Chipmasters just waiting for a cheap solution.

An experienced guy should get one for scrap value and rig an external drive for the home workshop (see sketch); then he would have an excellent machine.

Comments on CAD

From D. Chandler, an industrial user of CAD, of Bury St. Edmunds

I note with interest the editor's remarks about CAD winning hands down in the case of complex drawings etc. If you believe that these machines are here to stay, and you have time and money to spare, then don't hesitate, as anyone suggesting they are slow, cumbersome and difficult to use will be considered old hat.

And from Pat Harrow of Faversham

I noted with interest the letter from Ron Dauben on Computers in home workshops and in particular the editorial comments.

I have been involved with CAD systems since the first ones appeared on the market, both from an industrial viewpoint and at home. Ron has mentioned an important point that should be understood. Ron stated "... I think I could have produced a conventional ink/pencil drawing in an eighth to a quarter of the time it would take to use a CAD package. Practice would obviously improve this." The editor states "...that for complex drawings, CAD will win hands down".

The main benefits to be obtained from the use of CAD are:

- 1) Consistency of drawing (particularly lettering).
- 2) Reduced modification time.
- 3) Ability to combine existing drawings to make a third drawing.

These points are applicable to simple CAD systems, the more advanced systems will also allow the extraction of data for other programs and the automatic insertion of data derived from external programs. It is the latter facilities and the ability for reduced modification time that makes the use of CAD in industry economic. You will note that reduced initial drawing time is omitted.

Experience has shown that the task of producing a drawing may be split into two activities:

- a) Producing the lines (about 5 to 10% of the total time taken).
- b) Thinking time (90% to 95%)

It is obvious that CAD will not help with (b) above. In general with a skilled operator the generation time for the initial drawing (particularly where an element of design is involved) will be the same for both hand and CAD methods.

(I agree totally with Pat, his comments are without doubt correct for the applications he is considering. However, my comment should have said complex designs and not complex drawings. In this case, my experience has been that there is frequently an element of draw and redraw, thus gaining the CAD benefits that he indicates. Also in industries such as electrical and electronics, much of a new drawing can be imported in the form of ready drawn symbols and circuit elements- Ed.).

Praise where praise is due

From N. Lancaster of Blackpool.

I had recently to contact Crawford Collects Ltd over a problem with a Dixon Tool holder of which they are now the manufacturers. The service and assistance I received could not have been surpassed by anyone.

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Methods of the past

Here is a chance to share your knowledge of methods of the past, and possibly win a prize for your efforts.

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Could I therefore ask you to bring the enclosed leaflet to the attention of your readers in the hope that at least some of them will put pen to paper and let us know what the hard evidence is as to how the job was really done (as opposed to how the text books suggest or popular belief says it was done)?

Copies of the leaflet giving details of the competition, together with an entry form are available from: Brian Read, The Tool and Trades History Society, 20 Windley Crescent, Darley Abbey, Derby, DE22 1BZ.

Morse tapers and parcel tape

From M.R. Ashmore of Bourne, Lincs.

A Morse taper has to be very accurate, or it is useless for its intended purpose of positive location and gripping of a shaft in a holder.

If the tailstock offset method is used the formula for calculating the amount of offset is:

$$\text{Tailstock offset (in.)} = \frac{\text{taper/ft.} \times \text{length of workpiece (in.)}}{24}$$

This gives an initial set-up but is seldom good enough to give a proper fitting taper. Micrometer readings must be taken at a known distance apart to calculate the taper produced and to allow for adjustment during the turning process. I use a short piece of parcel wrapping tape stuck to the top of the workpiece to fix the distance apart of the two micrometer readings. By lining up the spindle with the edge of the tape, reasonable consistency of reading is possible if precautions are taken.

Firstly, don't wrap the tape completely round the taper or you may rest the anvil on the tape on the underside of the taper which cannot easily be seen. Secondly, don't attempt a reading until a sufficiently long taper has been cut to accommodate the tape plus two micrometer anvil positions.

The target difference in readings can be calculated by:

$$\text{Difference} = \frac{\text{taper/ft.} \times (\text{tape width} + \text{one spindle dia. (in.)})}{12}$$

In the above formula the micrometer spindle diameter is included to cater for the fact that the spindle and anvil at the larger diameter actually contact the taper one spindle diameter up from the edge of the tape. When the correct taper is achieved the piece can be tried in the bore before continuing turning to size.

I shall probably find that old timers have been doing this for years but it was new to me and may be helpful to someone.

Machine tool quality

I had anticipated a flood of letters on the subject of the value for money of third world machines as raised by P. Stallard on page 8, issue 19. I received only a few. Those received all agreed with comments contained in this letter from Alan Jeeves.

The observation by P. Stallard in Scribe a line (issue 19) concerning 3rd world made machinery should attract much comment. Yes many articles appear in magazines on the subject of improving a mill/drill (or whatever). I can go back quite a long way with Model Engineer, where many, many articles have appeared along the lines of improving the ML 7. The fact that the owner wishes to improve his equipment is not evidence of it not being worth its price.

I own a Taiwan made mill/drill (Nu-tool) which I purchased secondhand. In order for me to do this someone, in the first place, had to buy it new. I also own a Chinese bench drill which I acquired new in 1987, it has given excellent service. For my £65, at the time I could not find a good secondhand Western made machine of similar capacity. Some of the portable drill press stands exceeded this amount.

A spot of trouble arose with my 5in. offhand grinder which had given many years good service. I decided that the U.K. made machine could be replaced with a Chinese or Taiwanese effort cheaper than the repair costs for my existing machine. Today this same grinder sells at under £30 including two wheels. By making new wheel flanges I discovered that I could use 1in. wide wheels instead of 3/4in. Again 5 or 6 years of regular service has been gained from it with no sign of failure.

If I had been a generation older I guess I would not be able to enjoy the same level of furnishing of my workshop as I can today. I would probably have had to be satisfied with a (good) lathe and perhaps a small milling machine, which would most likely be hand operated (not motorised spindle) as would a shaper were I fortunate enough to be able to afford one at 2½ times an average week's wage. Did model engineers really buy new rotary tables then? - Chronos advertise 3 different ones in M.E.W. No. 19. I could buy on credit. In 1950 a Zyto 3 1/2 in. lathe would set me back £25-50 for cash or £6 down and £1-75 a

month for the next 12 months. I would have had to carry out certain improvements to it, one of which would be to supply and fix my own electric motor.

Returning to my mill/drill, it is of quite good proportions and has enabled me to make other items of workshop equipment which in turn have been used to improve the mill. Inferior quality or not I normally have a waiting list of people who want to come along and borrow it for the odd job or two.

My claim is that the 3rd world import has enhanced the lot of the amateur engineer over, say, the last 15 years by making available to him machinery which would previously have been out of the question. It may be argued that U.K. manufacturers could have provided more examples of small machinery specifically for amateur use and at a more attractive price – but the fact is that they did not.

Selecta band saw brazing machine

A number of replies have been received in answer to John Richardson's query on the subject of the Selecta and how it should be used. Here are three replies:-

A similar device and a simpler device

This letter from Dr Peter Clark of Southwold

I was interested to read the query on this subject in the current issue of M.E.W. I have a very similar brazing machine to the Selecta model illustrated, mine being an Ideal Model 80, of German manufacture. The top part of the machines seem to be almost identical, but the lower part, housing the transformer, is different, with my machine having a lever marked "I" and "II" rather than a switch marked "Braze" and "Anneal" as in your illustration. I had some instructions with my machine and enclose a photocopy for your correspondent.

The secret of success in brazing band saws may well be in efficient annealing of the area of the join, which may otherwise be so brittle that failure is inevitable. One of my friends, Len Evans, silver-solders his saws by using a simple jig and applying the heat with a pair of old pliers heated to bright red. He cannot remember where he first heard of this ingenious idea; but does not claim that is original. This method provides an in-built annealing process.

Finally, I seem to recall that Selecta was a trademark of the B. Elliot Company from North London.

The method

E.R. Carter of Kingston-on-Thames provides us with the method for using the Selecta bandsaw brazing machine.

The band saw brazing device shown on page 10 of issue 19 used to be quite common in toolrooms until butt welding machines became available, their operation was as follows:

- 1) Grind or file the scarf joint on each end. (Colin Smith of Harpenden also points out the preference for this to be done), ensuring the teeth on each half line up when joined, at the same time as maintaining a constant thickness

through the joint.

- 2) Clean faces and coat with silver solder flux.
- 3) Place in screw clamps and tighten.
- 4) Insert silver solder foil.
- 5) Switch to braze.
- 6) Switch on power until solder melts.
- 7) Pull handle down clamping joint and by the same action cooling it.
- 8) Release handle.
- 9) Switch to anneal.
- 10) Switch power on until joint shows dull red.
- 11) Switch power off and wait until joint cools.
- 12) Remove from machine and trim as required.

Tempering by colour

A.V. Booth from Tavistock largely agrees with the method of operating the Selecta as in the previous letter, but takes a slightly different approach to annealing.

On reading M.E.W. for Oct./Nov. I realised that I may be able to help Mr. Richardson and indeed Mr. Hodgson. I hope this latter gentleman will forgive me if I say that I think he is making hard work of what is a relatively simple, if at times, rather frustrating exercise.

As a toolmaker, with many years experience in industry, I have had quite a lot of opportunity to practice bandsaw joining. Since many companies have either no blade joining equipment or it is defective one soon learns to do it yourself.

The bandsaw joining jig as illustrated is very similar to the one I use, the important consideration is the careful grinding of a long, accurate scarf. This ground surface should not be touched but carefully silver soldered in the jig, the surface cleaned up with emery in the jig. Be careful, the blade is very brittle at this stage; and then tempered back to purple (the emery cleaning is done so that the tempering colours can be seen).

Don't be downhearted at initial failures, this is not a technique to be mastered in five minutes, it will take practice.

When using the Selecta for annealing the R.H. switch is turned to "Anneal" and the L.H. switch "jogged" on and off until the blade is well tempered back, the clamping action of the centre handle acts as a heat sink and renders the blade very brittle.

Models without a machine shop.

From P. C. Westcott of Blackwood FWD Australia.

I have intended to write to you personally, but something always seemingly intruded, but it was the Readers Survey and your comment under "Correspondence received" that acted as the catalyst.

In answer to question 41, I do not want to make steam engines, traction engines, radio controlled models, though from all model magazines available, they seem to be compulsory. I would however very much like to be able to make scale working models, particularly of large cranes of the types found in dockyards, power stations, building sites, railway sidings etc.

These items could all be made from wood, light steel or aluminium angles, channels etc. pinned, undercoated and finished in the bright industrial colours as used in factories today would be most effective.

Taking this a step further, many years

ago the English Practical Mechanic used to advertise blue prints of various DIY projects at a very reasonable price, and I remember my father buying one and making a very useful telescope, well it was to him as he was very involved with the S.A. Astronomical Society. So why not follow suit, do the same make these, and either model plans available at a reasonable price, and cater for those of us who do not have the machine tools.

I hope something will come of this, for I feel there must be many who desire to make scale, working, engineering models but, like me lack the machines with which to do so.

(The Argus 'Plans Handbook No. 2' price £2.95 + 80p, p&p, lists thousands of models and around 60 items of workshop equipment. A few engineering models are made from wood and card, unfortunately, no cranes. Can any reader suggest a source? Ed.)

Editorial preference

I find rather irritating your practice of "introducing" readers letters in Scribe a Line, also breaking in with asides and comments. The mixture of plain and italic type makes for confused and disjointed reading. How about letting readers contributions stand on their own merit?

R.T.C. Biggs
Camberley

Some further design changes

IDP (Sorry cannot read signature - Ed.) of Brierley Hill suggests modifications to the Instrument makers vice in addition to those proposed in the article in issue 18.

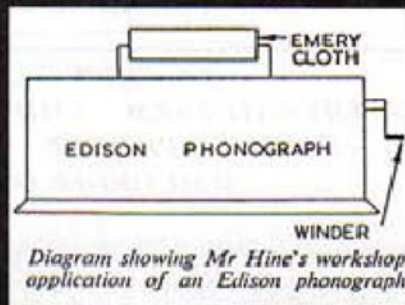
With reference to M.E.W. No 18 dated August/September 1993, firstly may I congratulate you on the production of a first class magazine, and secondly with reference to article Instrument Makers Vice,

QUICK TIP

Here is a quick tip from Model Engineer of 1 November 1956. I would suggest that if you still have one of these devices, you would be advised to sell it as a collectors item!

SAVES FILES

SIR-Being an old reader of Model Engineer I am sending a little idea which I find very useful in my small workshop. It is derived from an old Edison



phonograph by just gluing a piece of emery cloth on the cylinder. I found this saved me the expense of many a file. When these old machines are wound up they will run for approximately 20 minutes.

Thos. Hine,
Barrow-in-Furness

may I offer the following for your benefit and perhaps that of your wider readership.

The article in question deals with the manufacture of a small vice using cast materials supplied by The College Engineering Supply and the author undoubtedly prepared the article more as an insight into milling machine techniques as opposed to the manufacture of the vice.

On seeing the article, I decided to manufacture a similar vice, the base of which was fabricated from stock materials. Whilst in the process of manufacture I have retained the same basic principles as the original design but have incorporated several modifications which you may be interested to learn of as follows:

The base to my vice remains unaltered in design from the published article, however, I suggest the following

improvements will enhance the efficiency of the vice/clamp part of the tool.

The design as published uses the same principle to clamp material as a "normal bench vice". I have substituted a second screw in place of the lower guide bar on the published design, acting through the fixed jaw and bearing on to moveable jaw, as normally found on a conventional "tool makers clamp".

The second modification/refinement I have carried out, is to case harden the working faces, and top faces of both the moveable and fixed jaws, which I hope will prolong the working life of the vice.

A third modification, which I must admit, I have not actually implemented on my own vice, but wish I had prior to hardening the jaws, is to machine a small 'vee' grooves in the fixed jaw inside face running

both horizontally and vertically, this to enable small components of circular section to be held more easily.

I have also dispensed with the Tommy bar, for operating the main screw of the vice, instead I have knurled both the screws on my device having equipped both with through holes for the unlikely event of ever needing a tommy bar, although finger pressure is sufficient for the capacity of the vice, using the screw jacking principle of the method I've described.

I forward these notes to yourself; you may wish to pass them to your readership via the medium of Model Engineers' Workshop but I must reinforce that they are not meant as a criticism of the original article or its author but are presented as a means of producing a more efficient similar Instrument Makers Vice.



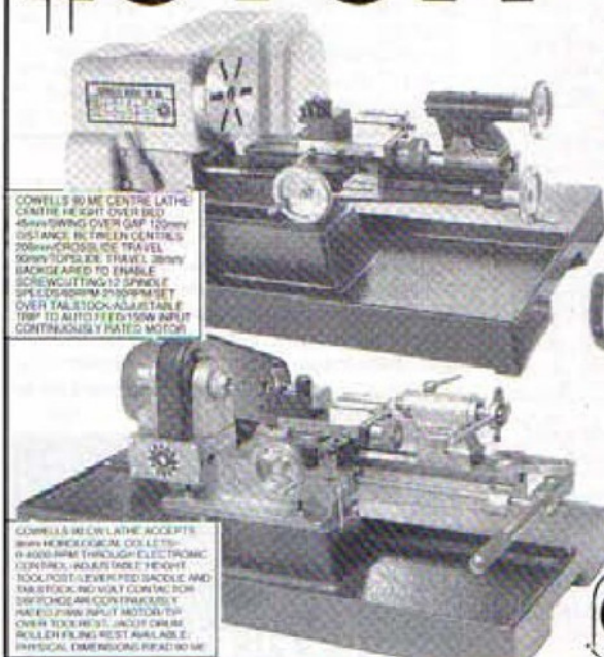
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